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AUTOMOTIVE INDUSTRIES

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AUGUST 28, 1937

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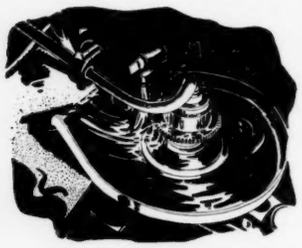

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Speeding up production on gear shapers in a Michigan manufacturing plant recently presented a problem in gear cutter maintenance. Under high speed operation, excessive tool wear indicated the need for a better cutting oil but the plant manager, objecting to the higher cost, tried out a number of low-priced lubricants.

With the best of these cheaper oils the cutters produced only 15 to 18 pieces per grind and it was necessary to grind off each cutter an average of .015 of an inch to put them back in shape.

Here's where the Standard Lubrication Engineer came in. He recommended a special high grade cutting lubricant. Tests on this oil showed an increase to 30 pieces per grind and less than .005 of an inch removed from the cutters at each grind.

Increased output and the saving in cutter life made the cost of this higher priced oil a negligible item. There's a Lubrication Engineer in your local Standard Oil office ready and willing to give you this same helpful service on any metal cutting operation.

Standard Oil metal working lubricants include:

PREMIER CUTTING OIL
ACME CUTTING OIL
SUPERLA SOLUBLE OIL
STANDARD PASTE COMPOUND
MINERAL SEAL
STANOSTAMP

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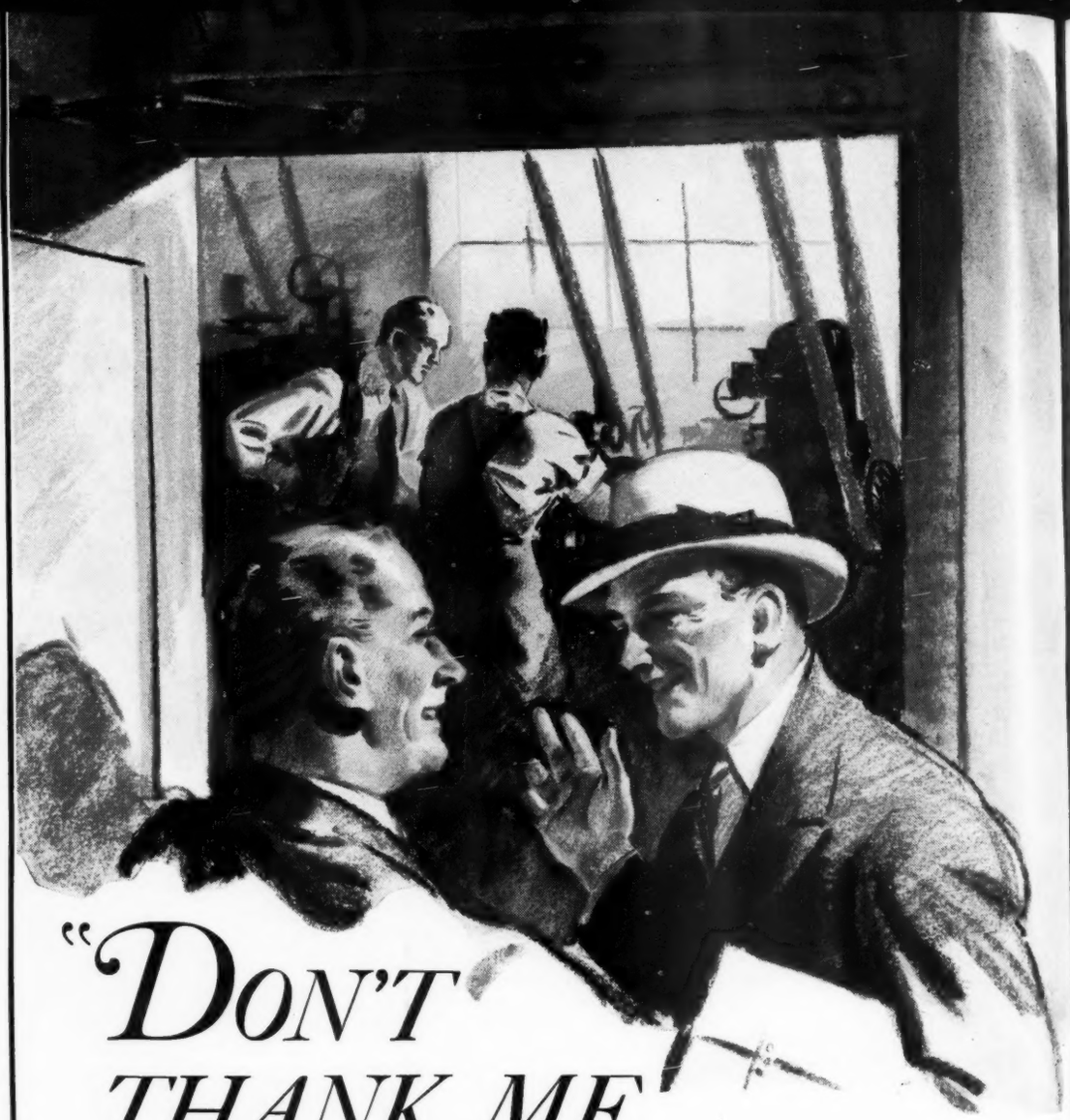
"LUBRICATION IN GRINDING OPERATIONS"

A booklet by this title is available to you from Standard's library of monographs. It covers the important factors of operation on external, internal and centerless grinding and the oil requirements for these operations. On the theory that an understanding of the problem is half the solution, this booklet will be valuable to those men interested in reducing grinding costs. Write for this or booklets listed below. Address Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois.

"Lubrication in Honing & Lapping"
"Lubrication in Gear Cutting"



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It's plain common sense. The superintendent, in this case, was the man who called in the Engineer. His foresight was directly responsible for whatever saving resulted from their study of the lubrication problem.

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When you call a Standard Engineer he works *with* your organization, contributing his knowledge in a spirit of helpful cooperation. His only reward for the savings you make is the good will it brings his company and Standard Oil products.

This helpful, friendly service is yours for the asking. Just call your local Standard Oil (Indiana) office and ask for a Lubrication Engineer.

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STANDARD OIL COMPANY (INDIANA)

LUBRICATION ENGINEERING

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AUTOMOTIVE INDUSTRIES
The AUTOMOBILE

Reg. U. S. Pat. Off.
Published Weekly

Volume 77 Number 9

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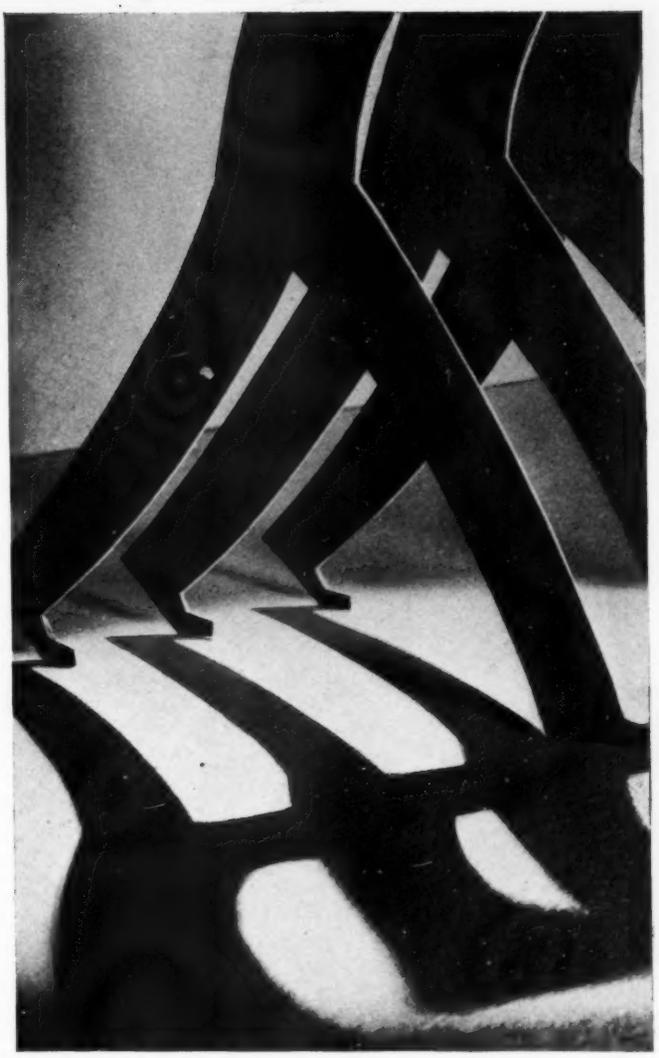

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Auburn, through sixty years' experience in conquering the most difficult jobs, has built up the facilities and personnel which enables us to take your biggest problems in our stride. Prompt delivery of finished products—of any molded plastic—made perfectly to the closest tolerances, are part and parcel of every Auburn job . . . big or little.

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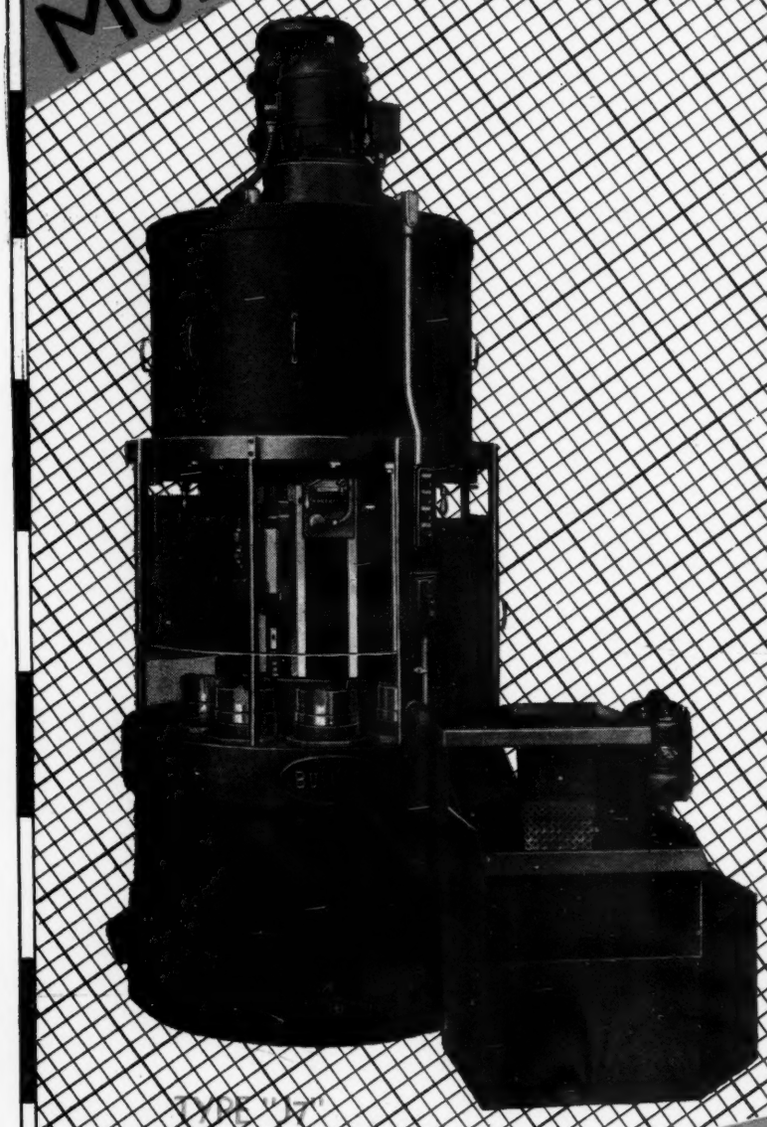

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Better mechanical Methods of Production are becoming increasingly important. Equipment of Proved Ability is the Profitable Investment. It is the practical answer to the Newer Economic Problems.

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The
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Bridgeport, Connecticut.

Published Weekly
Founded 1895

AUTOMOTIVE INDUSTRIES

August 28, 1937
Vol. 77, No. 9

Plants Busy on Model Changes

Output of 1937 Models Dropping Very Rapidly; Trickle of New Cars Coming Through; Parts Banks Being Built Up

Passenger car output is dwindling steadily as more and more manufacturers end activity on 1937 assemblies and prepare for quick changeovers to new model production. Four plants stopped assembly work this week, and an appreciable tapering down of output schedules for the following week signals the imminent shutdown of others.

Some producers have started turning out their new lines, although the number of cars actually being rolled off the assembly lines is small. However, several plants are in full swing on manufacture of 1938 model parts such as engines, crankshafts, and transmissions.

"Plant shutdown," applied to stoppage of old line assemblies for changeover is almost a misnomer. For instance, one plant which may be considered representative of most automobile manufacturing plants is a veritable beehive of activity although it has ceased making 1937 models. In addition to feverish work in installing new dies, new presses and other machinery, many departments are operating at top speed. Foundries must build up a supply of parts so that assembly operations will go along smoothly.

When the last 1937 model is run off in September, total production for the model year will undoubtedly go over the 5,000,000 mark.

With 100,000 units of this year's crop due to be harvested in September and 1938 models of several lines to come off the line at a good rate during the same month, output figures should move well above the 139,820 total chalked up in 1936.

Final Department of Commerce tabulations for July factory sales of passenger cars and trucks in the United States and Canada totaled 456,775 units, an increase of 5569 vehicles over the amount produced in the same month last year. Domestic sales alone were 438,834. Ford, since reopening Aug. 4 after the inventory-taking closure, has been turning out about 6000 cars daily and latest reports point to continuance of this pace. In all likelihood, Ford will be the last to "sign-off" on 1937 car production.

Apparently dealers in most makes have sufficient stocks on hand to supply sales demands until the new models are available. With the exception of several producers whose output schedules were impaired by strike interruptions, the general attitude with regard to the dealer situation seems to be aptly summed up by the comment "nothing to worry about."

The plants which have stopped production of 1937 models are Packard, Studebaker, Nash, Lincoln-Zephyr, Pontiac, Oldsmobile, Buick, Cadillac-LaSalle, Hudson and DeSoto. Chevrolet and Willys operations also halted for inventory this week. Chrysler and

(Turn to page 268, please)

International News Photo

TOM M. GIRDLER

. . . chairman of the Republic Steel Corp., much in the labor news recently, elected to the board of the Cord Corp. after new interest took over control.

Cord To Retain Profitable Units

Directors Preparing Reports for Sept. 15 Meeting When Plans Will be Further Discussed; Air Divisions Active

Future interest of the Cord Corp. in automobile activities will not be decided at least until the next meeting of the directors about Sept. 15, according to L. B. Manning, new president. At the first meeting on Aug. 20 of the corporation's board, since E. L. Cord sold his holdings to Mr. Manning and a group of bankers several weeks ago, Mr. Manning said that the fate of the Auburn and Cord lines of automobiles would depend largely upon what the board of directors of these companies might advise between now and the next meeting.

The name of the corporation will be changed, and Mr. Manning pointed out that only "profitable" units would be continued by the new corporation.

The newly elected directors at the meeting were C. Colburn Darling, Gerald Donovan, Victor Emanuel, Tom M. Girdler and Henry Lockhart, Jr., and L. B. Manning. R. S. Pruitt, vice-president and general counsel of the Cord Corporation, is also a member of the board.

Managers of the various subsidiary companies are making studies of new products and their markets. Mr. Manning said. At least some of these will be reported upon at the next meeting.

The Connersville, Ind., organization has been busy manufacturing a varied line of stampings for kitchen cabinets, refrigerators and other products. Auburn recently entered the air-conditioning field with an "all-year" air conditioner, and further expansion in this field is indicated in the recent purchase from the Russell Electric Co., Chicago, of the trade name "Aerofan," together with the patents and goodwill of the latter concern.

The Auburn Automobile Company has not manufactured Auburn or Dusenberg cars for some time and now has under considereation various suggestions concerning the Cord car. Auburn is now manufacturing bodies, parts and equipment, which type of business Auburn has been building up for the past several years. The company is also manufacturing a varied line of production stampings.

Lycoming Mfg. Co., Williamsport, Pa., will continue to make and sell the

(Turn to page 268, please)

URW Wins at Goodyear

CIO Union Gets Exclusive Representation Right

The United Rubber Workers of America, CIO affiliate, won a key election on Aug. 25 at the Akron plants of the Goodyear Tire & Rubber Co., giving it exclusively the right to represent the Goodyear employes. The B. F. Goodrich Co. election results will not be known until Aug. 30 as some workers will not vote until the Saturday preceding. About 26,000 workers of the two companies voted in all.

Vote in favor of the CIO unit at Goodyear was 8464 to 3193.

Thousands of employes of the Goodyear Tire & Rubber Company in Akron were in line long before voting booths were opened at eight o'clock Tuesday morning for the tire industry's first National Labor Relations Board election.

The Goodyear polls opened in an atmosphere charged with bitter factional feeling aroused by lost-minute campaigning via newspaper advertising and the radio by both unionists and anti-unionists. Senator Rush Holt in a radio address from Akron bitterly assailed the CIO and predicted an open break between John L. Lewis and President Roosevelt with Lewis heading a third party movement for 1940. Congressman Jerry McConnell was rushed to Akron by the unionists, and over the same radio station, answered the Holt barrage with a vigorous defense of the CIO.

Together the Goodyear and Goodrich elections represent the largest National Labor Relations Board election in history, with much depending upon the outcome. It is predicted that drives will be made for similar elections in branch factories throughout the United States of both Goodyear and Goodrich. Goodyear has branch tire factories in Gadsden, Ala.; Jackson, Mich.; Cumberland, Md., and Los Angeles and branch mechanical goods plants in several cities. Goodrich has branch tire plants in Oaks, Pa., and Los Angeles, with a new mechanical goods factory at Cadillac, Mich.

The Firestone Tire & Rubber Co., will not face similar issues until next April, having signed a contract with the URWA last April under which Firestone recognizes the URWA as sole bargaining agents for such of its employes as elect to have the URWA represent it. The contract culminated an eight weeks' strike at Firestone.

Knudsen Addresses Students

General Motors President W. S. Knudsen told 268 graduates of the GM institute at commencement exercises held in Flint on Aug. 24 that "Industry needs men with forward ideas. Employers of today . . . have obligations to the buying public, to the community and to the government, which means that all the brains and skill should be brought together for the best results."

The class of 1937 was the largest ever graduated by the institute and included students in the one year dealer co-operative course, the two year GM plan co-operative course, the four year GM plant co-operative course, and the fifth year post college graduate course in accounting.

In discussing immediate problems of the young graduates Mr. Knudsen said, "When you go out in the shops, remember that quality and low cost will always go together. Whenever you are able to help make something better, you are helping to lower the cost which brings the finished automobile closer to more people and increases its uses."

MAX HOFMAN

. . . newly named export sales manager, Waukesha Motor Co.

Briggs Buys Property

First steps in the Briggs Mfg. Co. expansion plan were indicated in the announcement that the company had bought from the Hudson Motor Car Co. about 17 acres of Detroit property which is detached from the Hudson plant and has never been used for production purposes. When Briggs failed to consummate its Motor Products merger plan, it was said that the company would proceed to make certain parts it formerly bought.

Continue Agency

Merle Sidener and Guernsey Van Riper are continuing their advertising agency business under the corporate name of Sidener and Van Riper, Inc., at their present location in Indianapolis. The association was originally made in 1910.

SAE Plans Tulsa Meet

Diesels to Have Place at Sept. 30 Forum

Two Oklahoma colleges will debate "The Diesel Engine vs. the Gasoline Engine for Automotive Applications" as a feature of the national regional fuels and lubricants meeting to be held by the Society of Automotive Engineers at the Hotel Mayo, Tulsa, Okla., Sept. 30 and Oct. 1.

Diesel fuels and gasolines, engine cooling, transportation and maintenance problems, aircraft and other subjects of particular interest to engineers in the mid-continent area will all be covered in this two-day forum, according to John A. C. Warner, secretary and general manager of the society.

B. E. Sibley, chief technologist, Continental Oil Co., as general chairman of the meeting, is working in close cooperation with SAE Vice-President C. Herbert Baxley, International Aviation Associates, who represents the society's fuels and lubricants activity, sponsors of this event.

The program is scheduled as follows:

Sept. 30

"The Development of the Diesel Around Oil Country Problems"
C. L. Cummins, Cummins Engine Co.
"Economic Place of Automotive Oil Engines"
A. F. Campbell, Waukesha Motor Co.
"Oil Field Operations"
A. W. Herrington, Marmon-Herrington Co.
"Evolution of Bus Maintenance Practice"
Floyd Patras, Southwestern Greyhound Lines, Inc.
S.A.E. Activities
John A. C. Warner, SAE secretary and general manager

Oct. 1

"Gasoline Volatility"
H. M. Trimble and R. C. Aldon, Phillips Petroleum Co.
"Diesel Fuels"
Robert Bost, Continental Oil Co.
"Engine Cooling Problems"
F. M. Young, Young Radiator Co.
"Bringing the Private Owner Airplane Up to Date"
Mac Short, Los Angeles
Student Meeting—Debate—"Diesel Engine vs. Gasoline Engine for Automotive Applications"
University of Oklahoma vs. Tulsa University

UAW Tension Flares Into Open

Factional Fight Appears on Convention Floor at Milwaukee; Plan New Organization Work in Aircraft Division

Tenseness between rival groups striving for control of the United Automobile Workers convention erupted in a bitter battle on the Milwaukee convention floor the night of Aug. 25. It was touched off by Delegate John Anderson of Detroit, organizer for the tool and die trade, who launched a severe criticism of the handling of the convention by Martin and associates.

Anderson deplored the slow progress stating, "The saturation point has been reached on long-winded speeches." Martin, somewhat ruffled, charged the minority group with holding up the work of the convention, wasting auto workers' money, and indulging in destructive tactics. A hot debate followed in which Walter Reuther charged that the constitution was violated when committees were set up by the executive board rather than by executive officers.

Scores of delegates clamored to be

heard. In the midst of excitement an attempt was made to adjourn but voted down. Finally, after hearing several speakers on each side, Martin declared the session adjourned.

A resolution to change the union's name to the International Union of United Automobile and Aircraft Workers of America, to give recognition to the aircraft division was referred to the constitutional committee before being put to a vote. Although boasting some strength already in aircraft field, the union plans greater activity. Because the UAW also takes in agricultural implement workers, of which ten thousand are members, it was suggested that the only change in the name be in the word "automobile" to "automotive," that being descriptive without lengthening the name to ridiculous proportions.

Resolution No. 146 was adopted, providing for setting up a division for the organization of office workers in the automobile industry. A resolution was adopted condemning as detrimental to the best interest of the union the practice of members on the payroll of the international using their positions in promoting politics within the union.

Starting Thursday morning, the meeting place was changed to the Milwaukee Auditorium from Eagles Hall. John Lewis was expected later in the week. He will address the convention.

Factionalism cropped out early in the sessions of the convention which opened in Eagles Hall, Monday. A demonstration planned as a unanimous tribute to President Homer Martin on the opening day developed into a noisy but good natured display of strength by the rival groups. But it was evident from the outset that a tense situation had developed and as the business of the convention got under way it became apparent that each side meant to battle to the last for its cause.

The Martin group seeks to oust vice-presidents Mortimer and Hall and to centralize power in the president's office. The "unity" faction would have four vice-presidents sharing authority equally with the president. There are 1171 delegates registered carrying 1891 votes and representing 256 locals. This compares with voting strength at the South Bend convention of approximately 230 representing 65 locals. Present membership of 375,000 is claimed as against 30,000 at the South Bend convention in April last year. Number of organizers has increased to 168 from 8. The UAW also claims to have agreements with 400 companies including all major automobile manufacturers except Ford as against 16 agreements at the time of previous convention.

The campaign to organize Ford workers is being given considerable attention and it figures in practically all speeches before convention. One of the resolutions calls for special assessment of 25c. a month per member to finance the Ford campaign.

INDUSTRY INVESTS over $5000
in Equipment and Materials
TO PUT ONE AVERAGE WORKMAN TO WORK
Without the dollar, man cannot live. How many productive jobs can you think of that can be done without tools? Particularly is man's dependence on the dollar evident as industry becomes more and more mechanical. As tools become more complex and capable of producing more, they become more costly, and more dollars are required to set a man to work.
A leading automobile manufacturing company recently pointed out that they had to provide $2,008 of land and plants, $2,670 of machinery and $665 of raw materials in order to put one average workman to work. Add that up. It makes more than $5,000 for each worker's tools, using the word in the broadest sense.
Steel Industry Invests $11,500 Per Man
The steel industry requires still more to finance and maintain the average job. Here the figure required to put a man to work stands at $11,500. Of this amount, $8,990 is needed for the necessary real estate, buildings and other equipment.
This same story can be repeated in any industry. Railroads, for instance, in tracks, locomotives, roundhouses, terminals, and the like, provide more than $5,000 worth of tools for each worker.
Here is the secret of America's high living standard. We have more tools, more machines. The average American workman has more than the workman in other countries because he can produce more with the help of tools supplied him by his employer.
JOBS MAKE MILWAUKEE MIGHTY!

ADVERTISEMENT

inserted in the *Milwaukee Journal* while the United Automobile Workers convention was being held there. It is the first of a series which will appear as a co-operative campaign to acquaint the workers with the responsibilities industry assumes to give employment, and with the cost of the employment. The *Journal* felt that labor's cause is receiving such tremendous publicity that industry should no longer refuse to speak out for itself, and therefore solicited the fund from which the advertisement was paid. Contributors are local manufacturers in metal working, the city's principal industry.

Two Elections Delayed

The National Labor Relations Board has ordered two plant elections delayed because of the seasonally reduced number of men at work at the plants. The election scheduled to be held by the employes of the Globe Machine and Stamping Co. will be held at the future direction of the board. The City Auto Stamping Co. election will be held between Sept. 1 and 10.

Spokesmen for the American Federation of Labor have asked the Labor Relations Board to refuse the request of the CIO's United Automobile Workers' union for an election in the Allis-Chalmers Corp.'s Milwaukee plant. The CIO union had urged the election to determine if it should represent all the employes of the plant.

Joseph Padway, of the Wisconsin Federation of Labor, argued that wholesale inclusion of the plant's 8000 workers into an industrial union would take away the economic and legal rights of skilled craftsmen. It was his opinion that the Wagner act does not empower the board unequivocally to select "the appropriate bargaining unit."

Gets Engine Order

The Pratt & Whitney division, United Aircraft Corp., East Hartford, Conn., has been awarded a $380,609 contract for an undisclosed number of airplane engines and spare parts for the Navy Department.

After completion, the engines will be shipped to the naval aircraft factory in Philadelphia. It is understood the engines will be used in scouting observation planes now under construction for the Navy under terms of the Vincent-Trammel Act.

Chemical Society Plans

Technology of petroleum chemistry will occupy at least five sessions of an American Chemical Society meeting scheduled for Rochester, N. Y., Sept. 6 to 10.

Cord Plans Awaited

Manning Says Board Studying Units; To Drop Losers

(Continued from page 265)

Spencer heaters, aircraft, automobile and marine engines, and will undertake to intensify its activity in building engines to use artificial and natural gas. This line was introduced several months ago. Mr. Manning said that Lycoming will soon introduce a complete, automatic, controllable-pitch propeller and other aircraft component parts. A hollow steel propeller blade, developed under a new patented process, is an important feature of the Lycoming "prop."

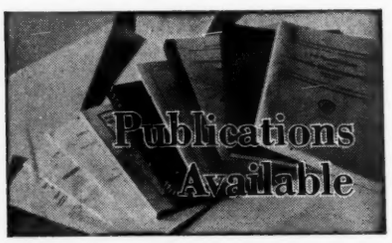
The Columbia Axle Company, all of the common stock of which is owned by Cord Corp., makes a dual-ratio unit or two-speed axle which, when installed with a universal transmission, provides six speeds forward and results in gasoline economy and better performance for automobiles. The Columbia Axle Company has recently completed contracts with three major automobile companies for use of this device as optional equipment on their 1938 product.

American Airlines, in debentures of which Aviation Corp. has a substantial investment, has been enjoying a rapid growth of business.

The Vultee division (attack and bomber aircraft) of Aviation Corp. is booked to capacity for the next 20 months, and the Stinson Aircraft Corp., another Aviation Corp., subsidiary, is today the largest manufacturer in this country of cabin aircraft for individual use.

Contracts have been recently signed by Checker Cab Mfg. Co. with two non-affiliated fleet operators to supply their entire requirements for taxicabs.

Cord Corp. owns about 26½ per cent of the founders' shares of the New York Shipbuilding Corp., owners of one of the largest shipbuilding plants in the country. Complete shipbuilding machinery and ways capable of constructing the largest Navy and merchant marine vessels, are owned by this company at its Camden, N. J., plant. Despite rather unprofitable operations of this company during the past few years, Mr. Manning expects that this concern will obtain a fair share of shipbuilding work from the Navy and shipping companies.



A new and more complete **edition of the booklet** "Hard-Facing with Haynes Stellite Products" is being issued by the company which is a division of Union Carbide and Carbon Corp.*

A **product summary** on "tarnish-proof" lacquer No. 4527 has been issued by Roxalin Flexible Lacquer Co., Inc., of Elizabeth, N. J.*

Pamphlet giving **definitions of pig iron and ferro-alloys** has been issued by the American Iron & Steel Institute. It is section 1 of a projected Steel Products Manual series.

A folder of reference data for the **use of fittings for copper tubing** work has been prepared by the Imperial Brass Mfg. Co. of Chicago.*

Mine Safety Appliances Co., Braddock, Pa., has issued a bulletin describing the M.S.A. **salt tablet dispenser.***

Latest issue of the "Mainspring," issued by the Wallace Barnes Co., Bristol, Conn., contains an **article** on the number of turns delivered by flat coil springs. The company also offers a **handbook** of spring materials and design.*

National Highway Users Conference has issued a **bulletin of 1937 laws** affecting highway users.*

A new **catalog,** F 958, has been issued by Norma-Hoffman Bearings Corp. It includes data and drawings.*

* Obtainable from editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia.

Ford Backs Used Car Drive

Ford dealers throughout the United States during September will cooperate with the Ford Motor Co. in a second annual nation-wide used car and truck clearance sale.

The sale will continue throughout the month, with over 100,000 used car and truck sales as the goal. Ford Motor Co. is aiding the sale with an extensive newspaper advertising campaign.

Ford dealers throughout the country report they are in strategic position for such a sale. Increased sales of the 1937 Ford V-8 have built up dealer stocks. Price revisions have been made by many dealers. Renewed and guaranteed used cars will figure prominently in the national sale, it was explained. Ford dealers displaying the R & G emblem renew used cars in accordance with specifications laid down by the factory and issue a written, money-back guarantee to the buyer. In preparation for the approaching clearance, dealers have extended their participation in the R & G procedure.

July Car Registration Off

July sales of new passenger cars in the United States total 206,950 in the 31 states reporting registrations to date, the R. L. Polk & Company reported. This total is down 1.83 per cent from the same month last year.

July sales will be greater than the total of June sales, the Polk estimate of 365,000 indicates. June sales totaled 360,236.

Truck and commercial car sales in 32 states in July total 35,548. This figure is 3.18 per cent higher than in the same number of states in June and is minus 11.48 per cent compared to July of last year. The truck sales estimate is 60,000.

Busy on Model Changes

(Continued from page 265)

Dodge will probably wind up early next week.

DeSoto ceased production of 1937 cars on Aug. 24. This month's production has been averaging 2100 per week. Totol output for August will be about 6900 units.

Two independents are slated to make their new car announcements about the middle of September.

There will be no fall vacations in the Graham organization. This was the underlying note heard at a series of meetings held last week in various parts of the country by divisional sales managers for Graham-Paige Motors Corp. and their district representatives. The factory is still building 1937 Grahams and will continue to do so for sometime. Plans for the balance of the model year were discussed at the meetings, and the district managers were informed that Graham's program for 1938 would be announced late in October.

At the time the assembly line "breaks," an estimated 21,318 units will have been manufactured. Of these 41.04 per cent will be "Superchargers" an increase from 28.63 per cent "Superchargers" in 1936, and 6.5 per cent "Superchargers" in 1935.

The 1937 model-year production represents an increase in total units of 10.9 per cent over 1936 model year production, and 1936 was 4.3 per cent ahead of 1935.

Cadillac-LaSalle finished a record year with its 1937 models, General Manager Nicholas Dreystadt announced, when production reached 46,153 cars. The volume was 26 per cent better than the previous high mark of 40,965 cars set by the 1929 models and bettered last year's output by 78 per cent. The 1936 models ran 25,905 cars.

Sales of Hudson automobiles for the first half of August have been higher than for eight years, reports William R. Tracy, vice-president in charge of sales of the Hudson Motor Car Company. "Our total sales for the first two weeks of August of this year were 4644 cars," stated Tracy. "This is over twenty per cent higher than sales of the same period last year and in fact exceeds sales during the same period for every year back to 1929.

Overseas Sales Up in July

Sales of American vehicles overseas during the first seven months of this year totaled 284,465 cars and trucks, showing a gain of 34 per cent over the first seven months of 1936. Passenger cars increased 32 per cent and trucks gained 36 per cent during the same period, reported the Automobile Manufacturers Association. During the month of July alone passengar car sales abroad gained 39 per cent, trucks 62 per cent, and the combined total of cars and trucks gained 49 per cent over July of the previous year.

Newspaper Advertising Lags

Automotive advertising in newspapers during the month of July fell more than 10 per cent below the linage figures for July, 1936, according to Media's Records' figures cited by **Editor & Publisher.** The comparative figures for automotive newspaper linage follow:

	Lines, 1937	Lines, 1936	Per cent of 1936
July	5,902,641	6,592,673	89.5
June	7,332,243	7,644,775	95.9

Michigan Employment

Drops in July But Maintains Good Level Compared with 1936

Michigan's 68 automobile plants employed 310,547 workers as of July 15, a drop of 1.3 per cent from the middle of June, but 22.5 per cent more than were employed at the same time a year ago. Average weekly payrolls in these plants during July were $10.5 million, an increase of 2.4 per cent over the June average and 33.7 per cent better than the average for July a year ago.

Employment in the state's 60 plants included 37,136 workers on July 15, according to the Department of Labor and Industry. This represents a 30.1 per cent increase over a year ago, and a 5.2 per cent decline from the middle-of-June level. Payrolls in parts plants averaged $1.1 million in July, which was 52.2 per cent above July a year ago and 12.2 per cent less than the June figure for this year.

Tire Inventories Large

Shipments of pneumatic casings for June were estimated at 5,389,274 by the Rubber Manufacturers Association, Inc. This was a gain of less than 1 per cent over the May total of 5,374,654 and was a decline of 7.5 per cent from shipments of 5,793,014 made in June, 1936. Production in June was 5,339,238 against 5,351,638 in May and against 5,612,284 in June, 1936, from which latter figure it was a drop of 4.9 per cent. Inventories in the hands of manufacturers on June 30 were 12,528,789, against 12,592,215 a month earlier and 7,835,488 a year earlier.

Establishes Agency

Hal R. Keeling who as a member of the advertising agency of Sidener, Van Riper and Keeling has been associated with a number of automotive advertising accounts has established his own agency, Keeling & Co., in Indianapolis, and will service several national advertisers.

In addition to Mr. Keeling as president and treasurer, the agency personnel will include Don H. Collins, executive vice-president; William M. Hutchison, vice-president and secretary; Ernest Roose, art director; and Del Wakeman, production manager.

Gets Record Body Order

The largest order from any one customer ever taken by the Luce Mfg. Co. since it began business 7 years ago was booked recently by F. A. Schotters, president and general manager, when the White Motor Co., Cleveland, placed a contract for 1500 "Merchandor" bodies. The order represents over $650,000. According to Schotters, his company will begin delivery Sept. 1. Terms of the contract stipulate that no less than 50 bodies be delivered each week.

Hans Gustav Rohr

Hans Gustav Rohr, technical director of the Mercedes-Benz Company died at Stuttgart on Aug. 10. One of the most brilliant European automotive engineers, Rohr was interested in aviation and the building of aviation engines before the world war. After the war he produced the Rohr car which, in 1925 had an eight-cylinder engine and independent suspension all round. In 1930 he produced front wheel drive models and in 1935 he abandoned his own business to become chief engineer of the passenger car section of Mercedes-Benz at Stuttgart. Most of the present models were to his designs, and he was largely responsible for the design of the present Mercedes-Benz racing cars.

Dr. Alfred Wilm

Dr. Alfred Wilm, inventor of duralumin, an aluminum alloy responsive to heat treatment, died of heart failure on his estate in the Giant Mountains, Silesia, on Aug. 11. He was born at Niederschellendorf, Silesia, July 25, 1869. He studied chemistry in Breslau and upon graduation he became instructor in chemistry at the University of Göttingen where Woehler discovered aluminum more than a century ago. After a number of other connections he was appointed metallurgist at the scientific industrial laboratory at Neuhabelsberg, near Berlin, and it was there that he developed the alloy duralumin and a heat treatment for it. His American patents were seized by the U. S. Government during the war and licenses thereunder were issued to the Aluminum Corp. of America and the Bausch Machine Tool Co.

Studebaker Powered Planes

A standard six-cylinder Studebaker passenger-car engine has been granted an approved type certificate by the Bureau of Air Commerce. The engine is used in the "Arrowbile," a "Flying automobile" designed by Waldo Waterman. Five of the planes will be used by Studebaker in connection with national demonstrations to be held during the next three months. First public appearance of the planes will be at the National Air Races in Cleveland, Sept. 3 to 6.

Diesel Records Fall

Sixteen long-distance Diesel records, from 4000 kilometers to more than 13,000 miles have been passed by the International Association to the credit of a "Yacco Special." Although prepared and run by the Yacco Oil Co., the car is the Citroen Diesel placed on the market this year, having a four-cylinder engine of 75 by 100 mm. (2.9 x 3.9 in.) 107.8 cu. in.

The test took place on Montlhery track, and an average speed of 68.18 miles was maintained for eight consecutive days. The first record was for 4000 kilometers (2485.5 miles) at 70.04 miles per hour, and from this distance up to 20,000 kilometers (12,427.4 miles) all world's records were broken. The car also took records for 48 hours, 3, 4, 5, 6, 7, and 8 days. Of the 16 Diesel records, eight were established at more than 70 miles an hour.

The 20,000 kilometers and the 3, 4, 7 and 8 day performances also constituted international class E records, beating the records set up by various cars with gasoline engines.

Porto Rican Car Sales Up

Bettered conditions in Puerto Rico are reflected in figures released by the Puerto Rican Trade Council which show that purchases, by our Caribbean possession, of automobiles manufactured in mainland United States during the fiscal year ending June 30 increased 35.8 per cent in value over such purchases during the previous twelve-month period. Automobile sales to the island amounted to $3,001,818 during the 1936-37 fiscal year as against $2,209,947 for 1935-1936.

Truck Photo Offer Ends

The offer of $10 each for satisfactory truck pictures recently extended to amateur photographers by Ford Motor Company has been withdrawn, it is announced. Approximately three hundred pictures were submitted by photographers in all parts of the country. Of these, twenty-nine have been accepted and paid for and the remainder are being returned to the senders.

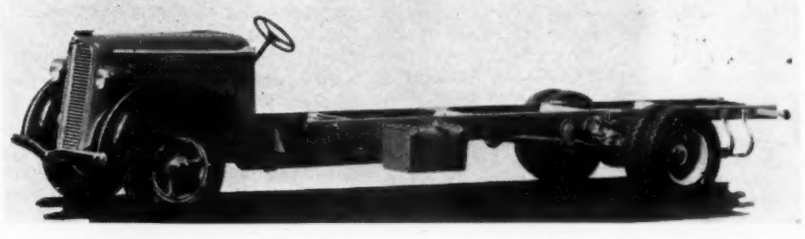
Stewart's 3-Tonner

Gives Company Broadest Line In Its History, Officials Say

A new truck chassis rated at three tons, with a gross capacity of 16,000 lb., and weighing 5840 lb. has been added to the line of the Stewart Motor Corp., Buffalo. The engine on the new line is a six with 4⅛ in. bore and 4½ in. stroke, with a piston displacement of 361 cu. in. and maximum torque of 225 ft. lb. at 1000 r.p.m. Engine lubrication is by pressure.

Standard equipment on the chassis, includes Stromberg downdraft carburetion, Delco-Remy ignition and Lockheed hydraulic brakes with a Bendix power booster.

Standard wheelbase on the new model is 144 in. with five longer wheelbases available as an extra option. Clutch is dry-plate type with vibration dampers. Transmission (standard) has five forward speeds with auxiliary three-speed transmission available at extra cost. Steering is Ross cam and lever.



NEW MODEL introduced by Stewart. Designated as Model 51A, the three-ton chassis is available in six wheelbases ranging from 144 to 220 in. Illustrated is the longest. It is powered by a six cylinder engine. The transmission has five forward speeds.

Business in Brief

Written by the Guaranty Trust Co., New York

Prospects Promising

General business was well maintained last week, and business quarters generally anticipate a high rate of activity during the remainder of the year. The weekly business index compiled by the "Journal of Commerce" stood at 102.5, as compared with 100.5 the week before and 91.3 a year ago.

Railway freight loadings during the week ended Aug. 14, amounted to 777,382 cars, which marks an increase of 7676 cars above those in the preceding week, a rise of 40,804 cars above those a year ago, and a gain of 163,377 cars above those two years ago.

Retail Sales Continue Up

Store chain sales continued their upward trend during July. The "Chain Store Age" index for that month stood at 114.5, based on the 1929-31 average as 100, as compared with 114.0 for June and 109.6 a year ago.

Production of electricity by the electric light and power industry in the United States during the week ended Aug. 14, was 10.6 per cent above that in the corresponding period last year.

According to the Department of Labor, the cost of living index for families of wage earners increased 0.9 per cent during the quarter ended June 15. All items composing the index, excepting fuel and light, rose.

Lumber production during the week ended Aug. 7, stood at 80 per cent of the 1929 weekly average. The level of output was 23 per cent above the volume of new business and 20 per cent larger than shipments. Production remained at about the same level as in the preceding week, although shipments and new business were considerably lower.

Fisher's Index Staple

Professor Fisher's index of wholesale commodity prices for the week ended Aug. 21, stood at 91.9, the same as for the preceding week, as against 91.8, two weeks before.

The consolidated statement of the Federal Reserve banks for the week ended Aug. 18, showed an increase of $1,000,000 in holdings of discounted bills. Holdings of bills bought in the open market and government securities remained unchanged. Money in circulation increased $18,000,000, and the monetary gold stock rose $30,000,000.

Seeks Road Law Checkup

Recommending that "appropriate steps" be taken to obtain greater uniformity in both state and local motor laws, the Bureau of Public Roads has filed a special report with both Houses of Congress urging strict and uniform examinations of drivers and more stringent traffic regulations and laws covering accident reporting in an effort to reduce traffic fatalities.

Another step being planned on Capitol Hill of interest to motordom was the consideration of a network of "superhighways" for commercial use on a toll basis. A special subcommittee of the House Interstate Commerce Committee will be asked to consider the subject further when Congress reconvenes, according to its chairman, Representative Lea, Democrat, of California. Although details of the plan were meager, Lea described the plan as providing for "broad, straight highways with a liberal number of lanes and no crossings," which ultimately would link all major industrial centers. The Congressman said the roads would be privately built.

MAX HOFMANN has just been appointed to the position of export sales manager of the Waukesha Motor Company, succeeding M. E. Nicklin. An engineer of considerable experience, Mr. Hofmann joined the Waukesha Motor Company in 1926, coming from the Argentine branch of Korting Brothers, German Diesel engine building firm. His work there as a Diesel installation engineer, his subsequent journeys throughout Europe, Africa, and both Americas, and his ability to speak four languages fluently make him well qualified for his new position.

M. E. NICKLIN, export sales manager, has resigned his position with the Waukesha Motor Company to return to the oil industry as assistant to W. C. Ramsey, manager of the machinery division of Oil Well Supply Company with headquarters at Oil City, Pennsylvania.

C. E. JEREMIAS and **E. A. SMITH,** field engineers, have been put in charge of the Mathews Conveyor Co., Detroit office, recently opened.

M. W. LADE, Chicago, has been appointed a vice-president and treasurer of the Globe-Union Co., Milwaukee, manufacturing spark plugs, storage batteries, radio parts and other specialties. **T. B. INGALLS** has resigned as secretary and is succeeded by **W. B. FYFFE,** formerly treasurer.

RICHARD SEIPT has been appointed sales manager of the Laminated Shim Co., Inc.

W. A. NEILL has been made manager of engineering and sales at the recently reopened plant of the Worthington Pump & Machinery Co. at Holyoke, Mass.

FREDERICK B. HEITKAMP, former vice-president of Lyon Metal Products, Inc., and for many years known to automotive men as sales manager of Cincinnati Milling Machine, has been advanced from general sales manager to vice-president of the American Type Founders Sales Corp.

CHAUNCEY WILLIAMS, Clintonville, has been made general factory foreman of the Four Wheel Drive Auto Co., it was announced by Walter A. Olen, president and general manager. Williams will direct production in the Clintonville, Wis., factory, assuming his new post immediately. The appointment was made following the sudden death last week of Curran C. McConvill, superintendent. A veteran factory employee, Williams entered FWD service in April, 1912. During the Mexican border disturbance, Williams had charge of testing trucks for U. S. Army service. On April 15, 1925, he was appointed foreman of machine shop No. 1, in charge of heavy production machinery, a post he held until his recent appointment.

STORRS J. CASE has been appointed director of advertising and sales promotion for the Graham-Paige Motors Corp. **R. B. BLANCHARD,** who has been acting advertising manager during the past year has been appointed sales promotion manager.

Oldsmobile Sales at Peak

Oldsmobile sales records have soared to an all time high, according to figures released from the office of D. E. Ralston, Olds general sales manager. During the first 20 days of August, Oldsmobile dealers delivered 11,943 cars at retail, an increase of 48 per cent over the 8054 deliveries recorded for the same period of 1936. Prior to 1936, the previous high record for the period was 7423 cars, established in 1935.

Oldsmobiles sales from Jan. 1 through Aug. 20 aggregate 141,665, compared with the previous high of 137,014 recorded in the corresponding period of last year.

Michigan Bumper Moves

The removal of machinery, supplies and all inventory from the Detroit plant of the Oldberg Manufacturing Co., a wholly owned subsidiary, to new quarters at Grand Haven, Mich., has now been completed, according to an announcement by John M. Crell, vice-president, Michigan Bumper Corporation. This move not only enables the company to concentrate all muffler production at Grand Haven, but will effect savings in capital investment and operating costs, it was stated.

G. A. Schreiber

G. Adolph Schreiber, consulting engineer, died Aug. 16 of injuries suffered in an automobile accident last month. He was born in Germany 56 years ago.

Hailing from the Daimler Motors Works where he had charge of tool design, Schreiber's first connection in this country was with the EMF on engineering and export matters. He was a production engineer for Willys-Overland when that company was reorganized by W. P. Chrysler. Later he served with the White Motor Co. and General Motors Truck Co.

Raises Dividend

Bohn Aluminum & Brass Corp. raised its dividend from 75 cents to $1.25 a share, the latest declaration payable Oct. 1 to stock of record Sept. 15.

. . . *slants*

SUCCESS—*The Gulf Oil Corp. has had such happy results from the use of its experimental "marsh buggy" that it has built a second one. The machine weighs 4000 lb. and combines the best features of a truck, tractor and boat. It is a framework, engine driven, and mounted on tires 120 by 33.50 in. The tires weigh 350 lb. each and carry only six lb. of air pressure. Speed is 20 m.p.h. on land, 12 m.p.h. in waist-deep mud, and 6 m.p.h. in water. It is used to carry men and equipment into swamps in search of oil.*

GHOSTS—*With the arrival of cooler weather, America's "ghost road" is beginning to disappear. This phantom highway, created by the expansion of concrete under the blistering rays of the summer sun, is estimated by G. J. Irwin, highway engineer of The B. F. Goodrich Company, as reaching a maximum aggregate length of 61 miles for the 111,350 miles of concrete highway in the United States.*

Irwin, checking tests on the new rubber expansion strips for filling the joints in concrete highways which has

been serving in experimental installations for more than two years, found that a regular 60-foot slab of concrete changes as much as four-tenths of an inch with a variation of 100 degrees in temperature.

ONE WAY TO WORK IT—*There is the usual amount of discussion in England about the effect upon a Fall automobile show of June and July car announcements. It is claimed that there is no real evidence of loss to the October show, but it is pointed out that some manufacturers are keeping at least one new model secret for show time announcement, while making others available now.*

HOW TO MAKE GLASS—*A 500-mile ribbon of car window glass, 51 in. wide, was produced recently in a record-breaking run at the Ford Motor Co. Dearborn plant. Molten glass at a temperature of 2200 deg. flowed into the rollers continuously for 139 consecutive days in establishing the record run. The round-the-clock schedule was maintained as long as possible, the superintendent explained, because glass making is a delicate business in which interruptions cause many complications. "The fact we were able to operate without a halt for more than four and one-half months shows both that the complicated machinery was in top condition and that the 'mix' was of uniformly high quality," it was stated. "This uniformity is made possible by constant checks all along the line, but even then you've got to have some luck to get off a run like this. More than 86 tons of molten glass flowed into the rollers every day of the run, and although the rollers are water cooled the terrific heat finally caused them to oxidize slightly. The glass began to stick, and the run was over." The glass strip is cooled very slowly to prevent flaws, and then is cut into convenient lengths for its trip through the grinding and polishing machines, after which it is assembled as safety glass.*

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

Drawing Card

Several Eastern fair managers are giving their patrons a glimpse at the motor vehicle this Fall. Such an attraction has proved a drawing card wherever advertised and has very perceptibly increased the gate receipts. Several Duryea wagons have appeared in these events, in some cases being the only entries. The Duryea Motor Wagon Co. wish to say that these wagons are entered by private parties and that they have no racing wagons in use at present. All wagons heretofore sent out are geared for actual road service and while they are much faster than the legal limits in most places, they are not racers by any means. It is not difficult to drive a properly built wagon a mile in two minutes, but buyers have not found use for such speeds in actual road service, which is the final criterion.

From *The Horseless Age*, Aug., 1897.

Automotive Metal Markets

Industry Active on Repair, Improvement Work at Mills; Still Waiting for Volume Automobile Orders

Relining of blast furnaces and repairs to steel-making machinery make up the major activity during the prevailing lull in the steel market. Some producers are virtually "taking time out" until order books permit more advantageous scheduling of operations. Others profess to see mild improvement in buying by parts makers, although the absence from the market of the large automobile manufacturers makes accumulation of tonnage business difficult.

By comparison with the position of sheet mills, which have some body stock orders placed earlier by the large consumers, strip steel makers are doing rather poorly, the current rate of strip mill operations being 15 to 20 per cent lower than in July. That this condition is looked upon as transitory, is shown by the letting a few days ago by one of the smaller "independents" of a $4,000,000 contract for the construction of a continuous strip mill.

Of considerable interest to automotive consumers was an announcement made a few days ago that one of the large sheet companies plans to reshear, roller-level and, when necessary, pickle "seconds." Quite a business has sprung up in recent years in the handling of seconds and off-grade sheets and strip steel. So-called shearing concerns would contract with producers for their "seconds" and prepare them for use by certain classes of consumers. Reclaiming of this sort of material by the original producer is certain to come in for considerable attention. Another interesting development is announcement by a large steel warehouse concern that it will undertake to select entire heats of alloy steels within narrow analysis limits, thus greatly simplifying heat treating. Complete data, which accompany each shipment, will eliminate the need for experimentation by the heat treating department.

Here and there in the pig iron market it is pointed out that reaffirmation of current prices to apply to fourth quarter contracts does not necessarily mean that there will be no advance over the remainder of the year. If scrap prices should score further heavy advances, the argument runs, pig iron prices would very likely be marked up. The more conservative marketers frown upon this sort of talk as poor sales strategy. It is well understood that the naming of prices by the quarter does not bind any one. What counts are signed contracts. So far, announcement of unchanged prices has not quickened business in the pig iron market nor have hints that they may yet be advanced before the end of the year.

In the tin market, the chief topic of discussion is a proposal by the Dutch East Indies producers to reestablish a buffer pool. Malayan interests contend that the setting up of such a reserve stock would bring about the very condition that it is sought to avoid, resulting in an entirely unnecessary price bulge that would soon flatten out and demoralize the market. Consumers have shown very little interest in tin offerings in the last few days. The market opened a shade easier at the beginning of the week. Spot Straits was offered at 59⅜ cents, compared with 59½ cents at the preceding close. Under lack of demand, the market eased off further on Tuesday, spot and nearby Straits offered at 59 cents. Copper ruled quite and unchanged at 14 cents, the market featureless. Leading producers of zinc say they are sold out over the remainder of the year. The lead market has turned quiet. Routine conditions prevail in aluminum.

W. C. H.

Trailers Get Floor at Show

As a result of formal approval by the Trailer Coach Manufacturers Association, the trailer section of the National Automobile Show in Grand Central Palace, New York, Oct. 27 to Nov. 3, will be even more representative than last year when 21 exhibitors showed a full line of 44 trailers of the passenger and business type.

The Trailer Coach Manufacturers Association states that its committee appointed to study the matter, "reports and recommends that all trailer manufacturers directly support exhibits only in the National Automobile Show, Grand Central Palace, New York, and the Chicago Dealers Show, for the year 1937. Nothing in the committee's report should be construed as opposing dealers exhibiting in local shows in their own areas, but it is felt that the manufacturers should not be imposed upon to the extent of supporting many sundry exhibits."

Bullard to Sell Stock

The Bullard Co., in a letter to stockholders calling a special meeting for Sept. 7, is asking authority to enlarge its capitalization through the issuance of 40,000 shares of convertible 5 per cent cumulative preferred stock of $40 par, and the necessary common shares for conversions. The company said that under the surtax law, it cannot build capital from earnings but must raise new funds.

Company Earnings

Willys-Overland Motors

Willys-Overland Motors, Inc., reported net income for the first half of 1937 of $950,400. The net was stated after all taxes except surtax on undistributed profits. After preferred dividend provisions, the earnings were equal to 42 cents per common share. No direct comparison is available as the present company began business on Oct. 8, 1936. However, a recent statement for the period Oct. 8 through May 31, 1937 showed net income of $504,541 or 20 cents a share, indicating recent improvement. In the final quarter of 1936 alone a loss of $395,630 was reported as the company prepared for new model production. The company is on a restricted schedule for two weeks preparing for enlarged production in 1938. Commercial bodies will be added to the line.

Thompson Products

Thompson Products reported net income for the June quarter of $459,774 or $1.53 a share, against $284,230 or 95 cents a share in the preceding quarter, and against $355,539 or $1.21 a share for the June quarter of 1936.

United Specialties

United Specialties reported income before taxes for the first half of the year of $106,202.

AUTOMOTIVE ABSTRACTS

Engine Test with Closed Air Jacket

Test on a six-cylinder air-cooled engine with completely closed air jacket were made at Stuttgart Technical College. A new cylinder block was set on the crankcase of a Mercedes-Benz six-cylinder water-cooled engine, with a bore of 2.91 in. and a stroke 3.94 in. Individual cylinders with cooling fins and a finned head were used, and the air was blown over these parts from side to side. Cylinders and heads were enclosed in a housing which confined the cooling air. Air entered the cooling jackets thus formed through ports, and these ports were shaped to give such a distribution of the cooling air as to equalize the temperature of the block as much as possible. To the cylinder cooling passages, for instance, the air was admitted through quadrilateral openings that were wider near the top than at the bottom of the block, so that the upper part would receive the most air. The compression ratio was 6.5 and the carburetor setting and spark advance were adjusted for maximum output, the fuel used being ethyl gasoline of 87 octane number.

The engine developed a maximum of 43.5 hp. at 3000 r.p.m., which corresponds to a b.m.e.p. of 74 lb. per sq. in. The fuel consumption was a minimum at 2300 r.p.m., at which speed it amounted to 0.54 lb. per hp-hr. The water-cooled engine on which the test engine was based had a maximum output of 45 hp. and its specific consumption was 0.594 lb. per hp-hr., but in making the comparison it must be pointed out that the power consumed by the blower of the air-cooled engine was not taken into account. To get the high output recorded for the air-cooled engine the carburetor air had to be taken from outside the hood.—*Kraftfahrtechnische Forschungsarbeiten No. 4.* (VDI Varlag, Berlin.)

The Angle of V Engines

It is well known that in V engines the angle of V has an influence on the torsional-vibration characteristics. This angle is generally chosen to give an even spacing of explosions, but it can be shown that other angles sometimes materially improve the "resonance curve," that is, a curve plotted on a base of engine r.p.m. and whose ordinates represent the torsional impulses due to the various harmonics of the gas pressure. In the case of an eight-cylinder V engine with 60-deg. angle of V there is a pronounced critical speed at a crankshaft speed equal to one-fourth of the frequency of the vibratory system. However, the amplitude of the vibratory forces in this case is only half as great as with an angle of V of 90 deg. The harmonic having a frequency equal to six times the crankshaft r.p.m. disappears entirely for an angle of V of 90 deg. (because the impulses due to the reciprocating parts of one bank of cylinders are displaced with respect to those due to the same parts in the other bank by $6 \times 90 = 540$ or 180 deg. and the two sets of forces are therefore directly opposed). In an engine of this type the impulses due to harmonics of six times crankshaft frequency reach their maximum for an angle of V of 60 deg.

The resonance curve shows another series of peaks for $n = n_e/8$, that is, for a crankshaft speed equal to one-eighth the natural frequency of vibration of the crank assembly, but these are of such low amplitude that they may well be neglected.

As regards twelve-cylinder V engines, the six-in-line with the firing order 1-5-3-6-2-4 gives rise to severe vibrating forces when running at speeds equal to the quotient of the natural frequency of vibration of the system by 3, 4½ and 6 respectively. The usual angle of V of 60 deg. is of advantage only if it is essential that the very strong harmonic of a frequency equal to three times crankshaft speed be eliminated. The harmonics of frequencies equal to 4½ and 6 times crankshaft speed respectively will then be very pronounced. If the angle of V is reduced to 45 or 30 deg., the harmonic of three times crankshaft frequency increases greatly, and, besides, down to 40 deg. the harmonic of 4.5 times the crankshaft frequency decreases, while the harmonic of 6 times the crankshaft frequency also decreases and becomes zero for an angle of V of 30 deg. An angle of 30 deg. is therefore advisable for engines whose operating speed is close to $n_e/4.5$, where n_e is the natural frequency of vibration of the crankshaft assembly, in cycles per minute.

The article contains a chart giving the ratio of the resulting amplitude of the torsional impulse R_g to that of the torsional impulse R due to one bank of cylinders for different angles of V and different speeds in terms of fractions of the frequency of the vibrating system.—K. Schlaefke, *V.D.I.*

Processes for Manufacturing Anti-Friction Alloys

There are two processes in use for the manufacture of anti-friction alloys with a lead base. One involves hardening of the lead by heavy metals and the other, hardening of the lead by metals of the alkaline or alkaline-earth group.

No very satisfactory results have been obtained with the first-named process up to date, from the standpoint of anti-friction qualities. One of these bearing metals, which is being offered on the market, is hardened with nickel, but it also contains a certain proportion of tin and a large proportion of antimony. Its composition is approximately as follows: Tin, 6.2 per cent; antimony, 15.65 per cent; lead, 75 per cent; copper, 1 per cent; nickel, 1 per cent; iron, 0.07 per cent; bismuth, 0.01 per cent. Its specific gravity is 9.81.

The second process has given better results. During the period of the World War there was placed on the market in Germany, under the designation "white-field-gray bronze," an alloy of lead containing 1.5 per cent of sodium which, by virtue of its hardness, was used as an anti-friction metal. The metals of the alkaline-earth group harden lead in the same way as sodium, and for that reason they can be substituted for antimony. However, the resulting alloys are slightly less corrosion-resistant.

Such a lead-type anti-friction metal, called "railroad metal," has the following composition: Lead, 48.97 per cent; calcium, 0.72 per cent; sodium, 0.57 per cent; silicon, 0.04 per cent; aluminum, 0.2 per cent. The alloy, moreover contains also a small amount of lithium. Its specific gravity is 10.5. As with all other lead-base anti-friction alloys, remelting and re-use of the metal under consideration always call for special precautions. Lead-base bearing alloys always have a higher melting point and therefore always give greater protection against burning out in service than tin-base alloys.

In the course of experiments to harden the lead with the aid of metals of the alkaline-earth type, additions were made of calcium and elektron (magnesium), for the simple reason that there were large quantities of the latter alloy in stock, in the form of old engine blocks. By successive increases and decreases of the proportion, very favorable results were obtained with 98 per cent of lead, 0.2 of calcium and 1.5 per cent of elektron. Later the elektron was replaced by pure magnesium. The resulting metal was called Union anti-friction metal.

For the manufacture of this metal, one-half pound of calcium and 3¾ lb. of pure magnesium in cubes are placed in a steel crucible. Then from 245 to 250 lb. of lead of any kind are added (old water pipes, lead bars, etc.). The whole is then covered with a plate of cast steel. It has been found that the magnesium, which is not yet molten when the lead passes into the liquid state, rises rapidly through the lead bath and then disappears in the form of dross. The cast-steel cover plate, which itself is covered with a little charcoal, prevents this loss of magnesium and by keeping out the air, also reduces the loss to the fire, that is to say, the quantity of cinders. The alloy is then cast as rapidly as possible.

Experience shows that alloys obtained in this manner are not always uniform with respect to their magnesium and calcium contents. For this reason the magnesium and calcium are now added by means of a cage immersed in the lead bath when the latter has attained a temperature of 1200-1300 deg. F.—*Stahl und Eisen.*

Plant Notes

As the first definitive steps in carrying out an appropriation of $3,500,000 to $4,000,000 recently made by directors of the Allis-Chalmers Mfg. Co., Milwaukee, largely for expansion of the industrial and farm tractor division, bids were closed Aug. 23 for the construction of a No. 3 tractor shop, 160 x 602 ft., and a gear department building, 212 x 225 ft., at the main works in West Allis (Milwaukee). On Aug. 30 bids will be closed on a new heat treating shop, 100 x 130 ft., at West Allis, and an assembly shop-boiler plant, 80 x 360 ft. and a storage house, 150 x 300 ft., 3-story, at the branch factory at La Crosse, Wis., where tractor and other farm implement production is concentrated. These projects contemplate an investment of $2,650,000. The boiler plant at West Allis is now being rehabilitated at a cost of $800,000. Although the heavy duty tractor works at Springfield, Ill., were enlarged at a cost of $1,000,000 during the past year and one-half, a further investment there amounting to $750,000 is planned, while $150,000 is to be spent for new machinery, tools and other equipment at the branch works in La Porte, Ind., where combines and other harvesting machinery is built.

La Crosse, Wis., plant of Moto-Meter Gauge & Equipment Co. will be substantially enlarged at once, contracts having been let for a fireproof factory addition, 111 x 166 ft. Work started Aug. 23. The new shop will house the assembly department, maintenance division and stock room, releasing 32,000 sq. ft. for production in existing buildings. When the addition is completed the floor space at La Crosse will be 230,000 sq. ft. At present the La Crosse plant is employing 1750 persons on two 9-hour shifts, 5 days a week. About 400 or 500 will be added to payroll upon completion of the new build-

ing. John Padesky is general manager at La Crosse.

The Garrett Body Co., Inc., has been formed at Garrett, Ind., to manufacture bodies for utility companies. Fifty men will be employed at the start, with 200 total within a year. The bodies will be of all metal welded construction of a new design. Sample bodies will be ready Dec. 1. The incorporators are Mickeal J. Sherlock, formerly with General Motors, International Harvester and Fruehauf; William Craig, accountant, and A. D. Beatie, draftsman.

Plans for plant expansion, due to increased demand from the automotive industry, and announced by Ferodo and Asbestos Inc., makers of brake linings, clutch facings and industrial frictional materials. Addition to the present New Brunswick, N. J., plant of a new building with 46,000 sq ft. of manufacturing space, and expansion of laboratory research facilities are included in the $400,000 program. The new buildings will be designed and equipped for the production of woven and molded frictional materials, and will approximately double present plant capacity. About 100 additional workers will be added to the employment rolls. A new two-story office building will be erected in conjunction with the new plant, the latter expected to get into production early in 1938.

Installation of three large presses in the sheet metal division of Cadillac-LaSalle that will increase the capacity of the department by 60 per cent was announced by General Manager Nicholas Dreystadt. The new presses are included in a $100,000 improvement and expansion program designed to permit "progressive line" handling of such sheet metal parts as front and rear fenders, gas tanks and radiator shells.

Rim Inspections Reported

July rim inspections by the Tire and Rim Association, Inc. covered 1,386,541 units in the sizes under 17 in. This was 81.5 per cent of the total inspections, and compared with 961,122 rims or 56 per cent of the total a year ago. For seven months the total was 11,693,652 or 80 per cent of the total against 7,615,187 or 59 per cent of the total last year. Larger passenger car sizes accounted for 26,422 units or 1.4 per cent in July against 469,756 or 27.4 per cent of the total last year. For seven months the figures was 197,334 or 1.4 per cent of the total against 2,755,270 or 21.5 per cent in 1936.

Total truck rim inspections were 251,106 in July, 14.8 per cent of all inspections, against 273,243 or 15.9 per cent last year. For seven months inspections were 2,401,559 or 16.4 per cent, against 2,252,049 or 17.6 per cent last year. Tractor rim inspections numbered 32,949 or 1.9 per cent in July, against 9,334 or 0.6 per cent last year, while for seven months the total was 297,433 or 2 per cent against 138,154 or 1.1 per cent of all inspections in 7 months last year.

Dr. S. C. Kang Visits U. S.

Dr. S. C. Kang, senior engineer of the Bureau of Roads of the National Economic Council of China is in the United States studying developments in highway, bridge and tunnel construction. Before returning to China Dr. Kang plans to visit Detroit, Chicago and a number of other cities in the United States studying recent developments in highway transportation.

TOOLS OF TOMORROW

Hydraulic Pumps

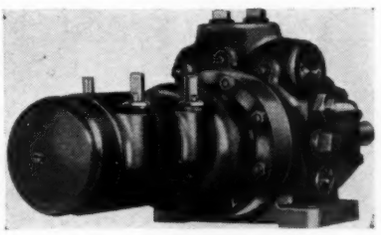
. . . control valves built into housing; two sizes offered

The Sundstrand Machine Tool Co., Rockford, Ill., has announced a new line of hydraulic pump units with the control valves built into the pump housing. The units are made in two sizes, the larger designated as model 10PWX, the smaller as 5PWX.

New element in the 10PWX unit is a variable displacement piston pump which can be furnished with three different feed rates: fast, medium and slow feed, each of which is independently adjustable. There is also a constant volume pump in this unit which provides rapid traverse. Both pumps are driven by a single shaft.

The main control mechanism is in the pump housing and may be actuated by a hydraulic remote control valve which is tripped by dogs on the moving member. Alternative control is by electrical switches and trip dogs in conjunction with solenoid valves.

Either the hydraulic remote control or the electrical switches provide the three pre-set rates of feed and rapid traverse in either direction. The same control arrangement is used for the 5PWX unit.



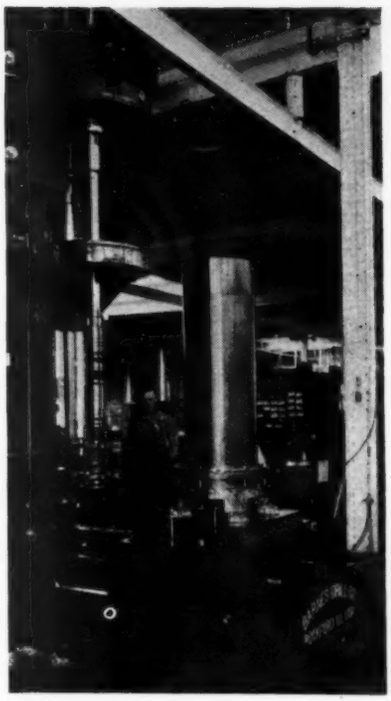
Sundstrand hydraulic pump with control valves built into housing

Hones

. . . up to 30-in. diameter handled by one of the largest vertical machines ever built

One of the largest vertical honing machines ever designed was recently built by the Barnes Drill Co., Rockford, Ill. It handles hones up to 30-in. diameter.

Eight changes of speed are controlled from levers at the operating position, there being three levers, one controlling the back gears and the other two each shifting two speeds. Shifter forks are operated by chain drives.



Barnes vertical honing machine which accommodates hones up to 30-in. diameter.

The machine illustrated herewith is set-up for honing a Diesel engine sleeve of 17½-in. diameter bore and 5 ft. long. Vertical spindle travel is 90 in. Height of the machine with the spindle up is 31 ft. 4 in. The work table, which is oil operated, has a working surface of 40 in. by 60 in.

Disk Grinders

. . . several sizes added to line of Cincinnati Electrical Tool Co.

Addition of several sizes of disk grinders to its general line of grinding equipment has been made by the Cincinnati Electrical Tool Co., division of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. These grinders are available in two models: (1) double end disk type shown in the illustration, (2) machine with disk on one side and conventional type grinding wheel and wheel guard on the other side.

Disks are of high grade steel accurately machined and balanced. The

(Turn to page 294, please)

TAKING the USL Battery Corporation's merchandising and advertising program to USL jobbers and their salesmen at district sales conventions being held during the latter part of August in Chicago, Minneapolis, Omaha, Atlanta, New York City and the home office territory, Niagara Falls. Left to right—W. E. Blank, USL sales manager; R. T. Pierson, USL vice-president and general manager, E. D. Giauque, vice-president, Baldwin & Strachan, Inc., advertising counsel.

Scarab Construction Is Patented

PATENTS bearing the rather general title, "Motor Car," are rather rare at this late date, but one bearing this title was issued to Wm. B. Stout, of Detroit, recently. It covers the general construction of Mr. Stout's Scarab car, though some of the features, and notably the suspension, have been changed in the latest design of that car.

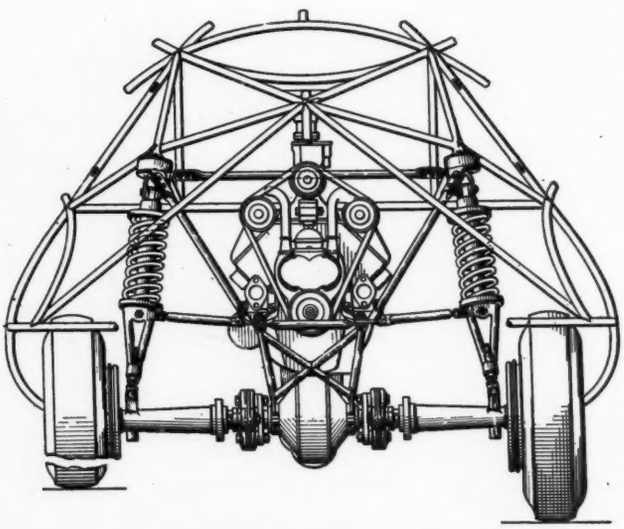
The body is resiliently supported on struts at front and rear in such a manner that its center of mass is swung from the tops of four columns standing on the axles, one close to each wheel. The powerplant and driving gear form a unit which is swung from the top of the two rear columns and supported thereby independently of the body. This method of carrying the load is said to make for stability and smoothness in travel and to go well with streamlined bodies. As the differential housing is spring-supported, universal joints are incorporated in the axle on both sides of that housing. The rear suspension is similar to the shock absorbers used for the landing gear of aircraft, comprising (in the design illustrated) a coil spring and a hydraulic shock absorber. The engine illustrated is the familiar Ford V-8 Model AA. The front end of the conventional engine housing is replaced by a special head which, together with a chain housing, supports the front end of the change-gear housing below the engine, the rear end of which is connected by a flanged tube to the front of the differential housing. This unit is resiliently mounted on the struts. Split collars on both sides of the differential housing connect by tubular stays to lugs on the engine casing, cross braces connecting the stays into a rigid frame.

Driving thrust and braking torque from the rear wheels are transmitted to the body frame by radius rods inclining from the rear axle housings at the base of the struts to the body frame at about the floor line and in front of the universals in the rear axles. The front end of each radius rod is formed into a fork receiving rubber washers on each side of a plate projecting rearwardly from the body frame.

The front axle is in two sections, each of which includes tubes with flattened outer ends welded to a short stub of a conventional front axle. The inner ends of the tubes are spread apart and terminate in bearings receiving rubber bushings and bolts by which they are hinged to plates welded to a tube extending along the bottom of the body frame lengthwise.

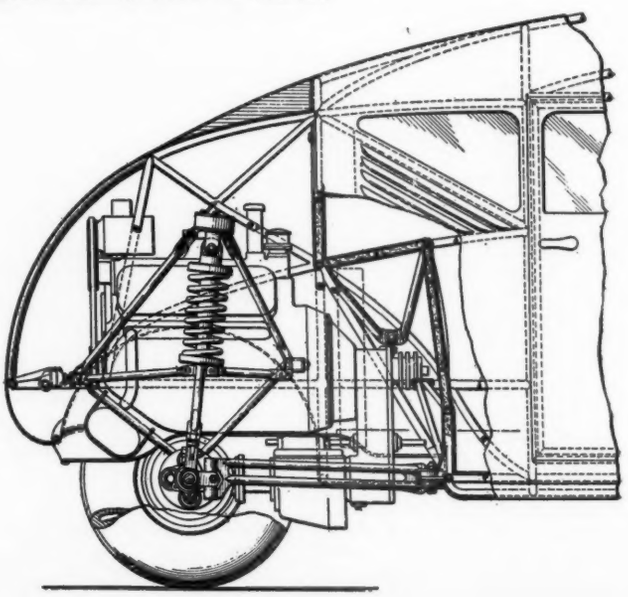
The invention is said to lend itself readily to embodiments for utilizing the highly developed radial engines as a source of power, and such an embodiment is illustrated in the patent.

Patent No. 2,047,336, Motor Car. William B. Stout, Detroit, Mich., assignor to Stout Motor Car Corporation, Dearborn, Mich.



The engine illustrated is a Ford V-8. The front axle is in two sections.

The front of the conventional engine housing is replaced by a special head which together with the chain housing supports the front end of the change gear housing below the engine.



Chevrolet Has Peak Month

Chevrolet sales figures for the first 20 days of August apparently indicate an August volume among the largest in the company's history.

Reports from dealers throughout the country showed 60,122 new units sold at retail through Aug. 20, furnishing the basis for expectation of a near-record month.

Combined new and used car sales for the period were 151,971 units, of which 73,675 were sold in the first 10 days and 78,296 in the second, a gain of nearly 5000 units in the latter period.

Truck sales accounted for about 21 per cent of the new units delivered, 13,014 of the total being in that classification.

Develops New Propeller

A new propeller said to provide airplane speeds as high as 300 m.p.h. and giving the most efficient pitch for all flight conditions was announced by Curtiss-Wright Airplane Co.

The propeller is of the three-bladed type with hollow steel blades. It changes mechanically the blade pitch formerly controlled hydraulically. It has an individual electric motor which will provide an increased pitch with a range up to 90 deg.

Burdette S. Wright, vice-president and general manager, revealed that the War Department has contracted for 240 of the propellers to be installed on pursuit planes. Cost of these propellers was estimated at $512,262.

Canadian Car Sales Up

Canadian new motor vehicle retail sales in July were 11,701 units, a gain of 41.2 per cent over last year, according to the Dominion Bureau of Statistics. During the first seven months there were 108,457 new vehicles sold, a gain of 29.6 per cent over the same period of 1936.

May Sell Preferred Stock

Stockholders of Allen Industries, Inc., approved the authorization of 40,000 shares of $25 par preferred stock to be issued when and if directors deem it advisable.

Letters

to AUTOMOTIVE INDUSTRIES

Disputes Aluminum-Head Findings of Bellevue Laboratory

The abstract* in AUTOMOTIVE INDUSTRIES for August 14, page 232, titled "Aluminum-Alloy Heads Tested," is so much at variance with the results of comprehensive research in both our own and other laboratories, that we feel it should have some comment.

It is perfectly possible for honest and able engineers to secure the negative results indicated in this article, by simply substituting aluminum heads for iron and by merely planing down the heads to raise the compression, without taking other factors into consideration. We know this full well, as in our own early days of experimental work on aluminum cylinder heads, we got the same results.

After several years of experience with the aluminum cylinder head and after thousands of systematic tests we have found that in order to achieve the much higher output possible with aluminum, it is necessary to properly design the cylinder head, valve timing and in some instances even the pistons, crankshaft and water circulation system, to meet the requirements of higher compression and higher brake mean effective pressure.

Speaking of cylinder head and combustion chamber design, this includes the form of the chamber for proper control of combustion, location of the spark plugs, compression ratio and the octane rating of the fuel to be used. The very fact that the source cited in the item discussed had a lower efficiency at 6.5 to 1 ratio than with the 5.95 ratio, is sufficient to indicate that something was wrong with other design features. Efficiencies should gain up to a ratio of from 8 to 8.5 to 1, in the light of present knowledge.

The engine should be inspected for a number of things. Its volumetric efficiency should be investigated, also friction losses as a result of piston or crankshaft distortion due to the higher working pressures, even crankcase distortion causing bearing friction is occasionally found.

No doubt the matter of proper spark advance was taken into consideration, but if a standard distributor was used with a standard advance curve designed for the iron head engine, it would be wrong.

To put the matter in another way, it is just as impossible to get the proper results by putting an aluminum head on an engine primarily designed with the limitations of iron in mind as it would be to try to use an iron head on an engine designed to have the higher output possible with aluminum.

This is not meant in a spirit of unfriendly criticism because it is easy to go astray on this subject and endeavor to get results by simply substituting the aluminum head for the iron. This seldom works. In order to get the results, it is necessary to design the engine so that it is mechanically as well as thermally correct. Given this condition it is possible to get smooth operation up to more than 8 to 1 ratio, with b.m.e.p. up to 135 lbs. per sq. in. with the aluminum head. Such an engine simply could not be operated with iron heads as we know them today.

DAVID E. ANDERSON, Engineer,
Bohn Aluminum and Brass Co.

*From *Revue de l'Aluminum*, reporting work of Bellevue National Laboratory, France.

Calendar of Coming Events

FOREIGN SHOWS

Poland, Automobile Salon (Foire Orientale), Lwow .....Sept. 1-15
Yugoslavia, Automobile Section, Autumn Fair, Ljubljana .....Sept. 1-12
Yugoslavia, Automobile Section, Commercial Fair, Belgrade.....Sept. 11-21
France, 31st International Automobile Salon, Paris .....Oct. 7-17
Great Britain, 31st International Automobile Exposition, London...Oct. 14-23
Czechoslovakian Automobile Show, Prague .....Oct. 16-24
Italy, 10th International Automobile Salon, Milan .....Oct. 28-Nov. 8
Great Britain, 13th International Commercial Automobile Exposition (trucks and buses), London...Nov. 4-13
Toronto, Ont., Automobile Show..Nov. 6-13
Great Britain, 36th Scottish International Automobile Exposition, Glasgow .....Nov. 12-20
Montreal, Que., Automobile Show, Nov. 20-27

DOMESTIC SHOWS

New York, National Automobile Show, Oct. 27-Nov. 3
Toledo, O., Automobile Show.Oct. 27-Nov. 3
Boston, Mass., Automobile Show, Oct. 30-Nov. 6
Los Angeles, Cal., Automobile Show, Oct. 30-Nov. 7
San Francisco, Automobile Show, Oct. 30-Nov. 7
Cincinnati Automobile Show.Oct. 31-Nov. 6
Akron Automobile Show .....Nov. 6-12
Brooklyn Automobile Show.....Nov. 6-13
Chicago Automobile Show .....Nov. 6-13
Columbus Automobile Show .....Nov. 6-12
Omaha Automobile Show.....Nov. 6-11
Detroit Automobile Show.....Nov. 6-13
Motor Truck Show, 4th Annual, Newark, N. J. .....Nov. 6-12
Newark, N. J., Truck Show.....Nov. 6-12
Buffalo, N. Y., Automobile Show..Nov. 6-13
Indianapolis, Automobile Show....Nov. 6-13
Newark N. J., Automobile Show..Nov. 6-13
Philadelphia Automobile Show....Nov. 6-13
Pittsburgh, Pa., Automobile Show.Nov. 6-13
Baltimore, Md., Automobile Show, Nov. 13-20
Cleveland, Ohio, Automobile Show, Nov. 13-20
Springfield, Mass., Automobile Show, Nov. 14-20
St. Louis, Mo., Automobile Show.Nov. 14-21
Portland, Ore., Automobile Show.Nov. 14-21
Denver, Colo., Automobile Show, Nov. 15-20
Jersey City, N. J., Automobile Show, Nov. 15-20
Milwaukee, Wis., Automobile Show, Nov. 17-24
Kansas City, Mo., Automobile Show, Nov. 27-Dec. 4
A.S.I. Show, Navy Pier, Chicago, Dec. 6-Dec. 11

SHOW BUSINESS

Manager of the National Automobile Show in New York is Alfred Reeves, 366 Madison Ave., N. Y. C. Inquiries concerning all matters connected with the national show should be addressed to him. AUTOMOTIVE INDUSTRIES will be pleased to furnish names and addresses of local show managers on request.

CONTESTS

National Outboard Championship Regattas, Richmond, Va. .....Sept. 18-19

CONVENTIONS AND MEETINGS

American Chemical Society, Rochester, N. Y. .....Sept. 6-10
International Congress on Carbohydrate Carburants, Rome .....Sept. 10-12
National Trailer Show, New York, Sept. 10-15
S.A.E. Section Regional Tractor Meeting, Akron, Ohio.....Sept. 15-17
American Transit Association, 56th Annual Convention, White Sulphur Springs, W. Va. .....Sept. 19-23
S.A.E. Section Regional Transportation Meeting, Chicago .....Sept. 29-Oct. 1
American Foundrymen's Association Midyear Meeting, Columbus, Ohio, Sept. 30-Oct. 1
S.A.E. Fuels and Lubricants Regional Meeting, Tulsa, Okla. ....Sept. 30-Oct. 1
S.A.E. National Aircraft Production Meeting, Los Angeles, Calif.....Oct. 7-9
American Foundrymen's Association, Regional Conference, Rolla, Mo., Oct. 8-9
National Battery Manufacturers Asso., Chicago .....Oct. 10-12
National Metal Congress, Atlantic City, Oct. 18-22
S.A.E. Annual Dinner, Commodore Hotel, New York .....Oct. 28
American Petroleum Institute, 18th Annual Meeting, Stevens Hotel, Chicago .....Nov. 8-12
S.A.E. National Production Meeting, Flint, Mich. .....Dec. 8-10

149 Automobile Plants

keep the world rolling in American cars

A GLANCE at the accompanying map of the world, on which has been spotted the factories of American automobiles, will convince one that they comprise a wide distribution and favored place in the ever rising sun for their products.

General Motors has in all 48 plants throughout the world. In the United States there are 28. Six of these are devoted to both the manufacture and assembly of cars and trucks while the balance, with the exception of the 12 Fisher body branches, are concerned only in assembly operations.

In the overseas field the branch factories turn out more or less of the entire G.M. line with local designs such as the Opel in Europe and the Vauxhall in England added. In Egypt and Mexico operations are confined to the production of Chevrolet trucks.

In Canada there is one G.M. plant producing all of the same lines as the American factories.

Ford supports 16 plants in the United States with the manufacture concentrated in Dearborn while the other 15 are assembly organizations.

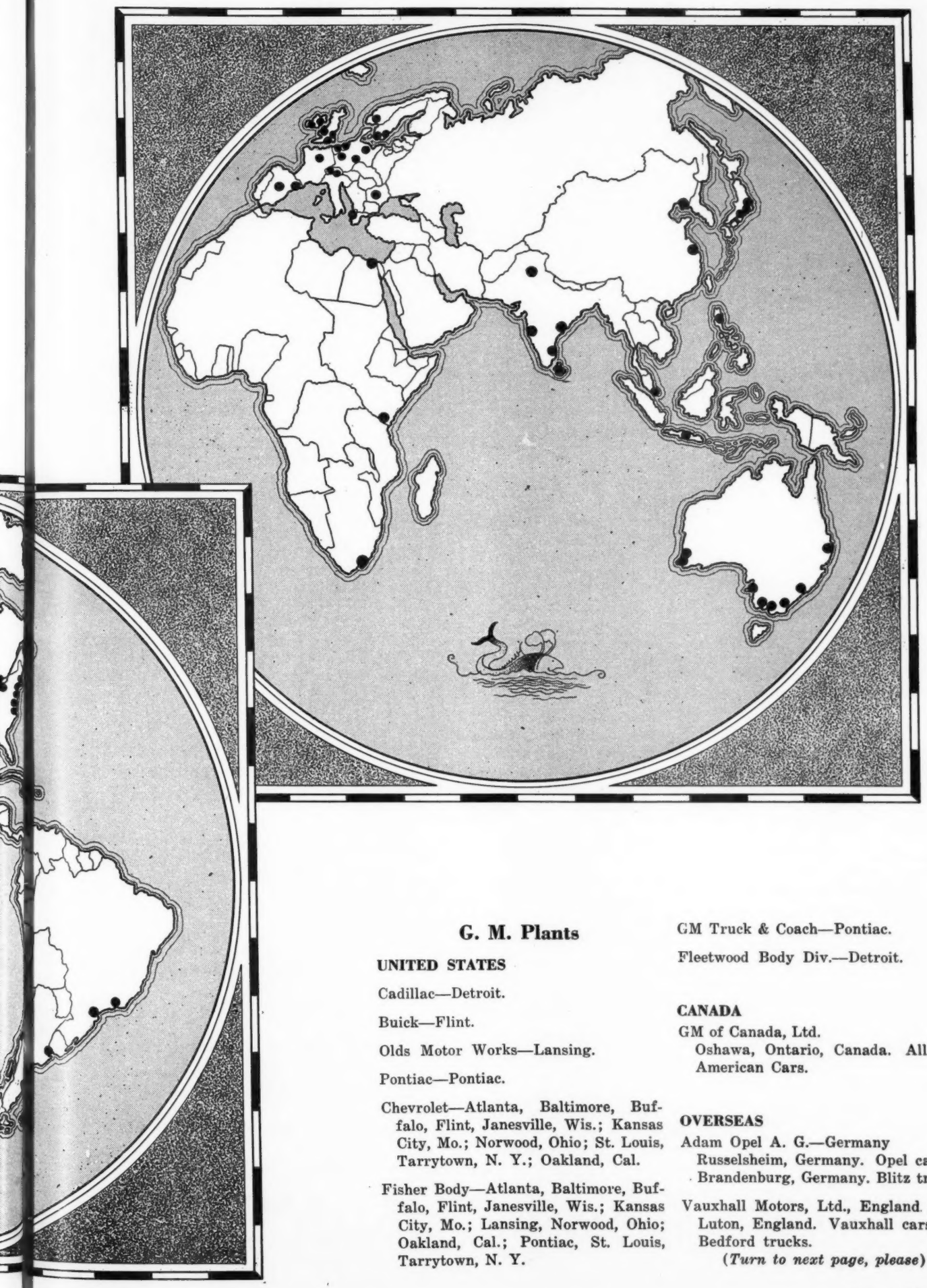
In Canada there are four Ford plants with the manufacturing centered in Windsor.

Ford has manufacturing plants in England, France, Australia, and Germany feeding 22 assembly plants scattered at strategic points.

The Chrysler organization is operating 38 plants, seven in the United States, one in Canada and 30 overseas.

Nash, Studebaker, Auburn - Cord, Hudson, Willys, Graham-Paige, and Packard account for 17 plants; 12 in the United States, four in Canada and one in Australia.

A tidy picture of the enterprise and agressiveness of the "men behind the guns" in the automobile companies of the United States. Following is the list in more detail.



G. M. Plants

UNITED STATES

Cadillac—Detroit.

Buick—Flint.

Olds Motor Works—Lansing.

Pontiac—Pontiac.

Chevrolet—Atlanta, Baltimore, Buffalo, Flint, Janesville, Wis.; Kansas City, Mo.; Norwood, Ohio; St. Louis, Tarrytown, N. Y.; Oakland, Cal.

Fisher Body—Atlanta, Baltimore, Buffalo, Flint, Janesville, Wis.; Kansas City, Mo.; Lansing, Norwood, Ohio; Oakland, Cal.; Pontiac, St. Louis, Tarrytown, N. Y.

GM Truck & Coach—Pontiac.

Fleetwood Body Div.—Detroit.

CANADA

GM of Canada, Ltd.
Oshawa, Ontario, Canada. All GM American Cars.

OVERSEAS

Adam Opel A. G.—Germany
Russelsheim, Germany. Opel cars.
Brandenburg, Germany. Blitz trucks.

Vauxhall Motors, Ltd., England
Luton, England. Vauxhall cars and Bedford trucks.

(*Turn to next page, please*)

G. M. Continental S. A.
Antwerp, Belgium
Cadillac, La Salle, Buick, Olds, Pontiac, Chevrolet, Bedford, Opel, Blitz.

G. M. International A/S
Copenhagen, Denmark
Buick, Olds, Pontiac, Chevrolet, Bedford, Vauxhall, Opel, Blitz.

G. M. Nordiska A/B
Stockholm, Sweden
Buick, Olds, Pontiac, Chevrolet, Bedford, Blitz.

G. M. Suisse, S. A.
Biele, Switzerland
Buick, Olds, Chevrolet, Opel, Blitz, Vauxhall.

G. M. India, Ltd.
Bombay, India
Cadillac, La Salle, Buick, Olds, Pontiac, Chevrolet, Bedford, Vauxhall.

G. M. Argentina S. A.
Buenos Aires, Argentina
Buick, Olds, Chevrolet.

G. M. DoBrasil, S. A.
Sao Paulo, Brazil
Cadillac, La Salle, Buick, Olds, Pontiac, Chevrolet, Blitz.

G. M. So. African, Ltd.
Port Elizabeth, S. A.
Buick, Olds, Pontiac, Chevrolet, Bedford, Vauxhall.

G. M. Holdens, Ltd.
Melbourne, Australia
Cadillac, La Salle, Buick, Olds, Pontiac, Chevrolet, Bedford, Vauxhall.

G. M. Holdens, Ltd.
Sydney, Australia
Cadillac, La Salle, Olds, Pontiac, Chevrolet, Buick, Bedford, Vauxhall.

G. M. Holdens, Ltd.
Brisbane, Australia
Olds, Pontiac, Chevrolet, Buick, Bedford, Vauxhall.

G. M. New Zealand, Ltd.
Wellington, N. Z.
Buick, Olds, Pontiac, Chevrolet, Bedford, Vauxhall.

G. M. Japan, Ltd.
Osaka, Japan
Cadillac, La Salle, Buick, Olds, Pontiac, Chevrolet.

N. V. G. M. Java
Batavia, Java
Buick, Olds, Pontiac, Chevrolet, Vauxhall.

G. M. Near East S. A.
Alexandria, Egypt
Chevrolet trucks only.

G. M. De Mexico, S. A.
Mexico City, Mex.
Chevrolet trucks only.

Ford Plants

UNITED STATES

Buffalo, N. Y.
Chester, Pa.
Chicago, Ill.
Cincinnati, Ohio.
Dallas, Tex.
Dearborn, Mich.
Edgewater, N. J.
Kansas City, Mo.
Long Beach, Cal.
Louisville, Ky.
Memphis, Tenn.
Norfolk, Va.
Richmond, Cal.
St. Louis, Mo.
Somerville, Mass.
Twin City (St. Paul, Minn.).

OVERSEAS

Amsterdam, Holland.
Antwerp, Belgium.
Asnieres, France.
Athens, Greece.
Barcelona, Spain.
Bucharest, Rumania.
Cologne, Germany.
Copenhagen, Denmark.
Cork, Irish Free State.
Dagenham, England.
Buenos Aires, Argentina.
Mexico City, Mexico.
Santiago, Chile.
Sao Paulo, Brazil.
Yokohoma, Japan.
Geelang, Australia.
Sydney, Australia.
Brisbane, Australia.
Fremantle, Australia.
Singapore, Straits Settlements.
Bombay, India.
Calcutta, India.
Madras, India.
Colombo, Ceylon.
Wellington, New Zealand.
Port Elizabeth, South Africa.

CANADA

Windsor, Ontario.
Toronto, Ontario.
Winnipeg, Manitoba.
Vancouver, British Columbia.

Chrysler Plants

UNITED STATES

Plymouth
Detroit
Evansville, Ind.
Los Angeles

Dodge
Detroit
Los Angeles

Chrysler
Detroit

De Soto
Detroit

CANADA

New Windsor, Canada

OVERSEAS

Christchurch, New Zealand
Wellington, New Zealand
Rio de Janeiro, Brazil
Buenos Aires, Argentina
Dublin, Ireland
Cork, Ireland
London, England
Antwerp, Belgium
Oslo, Norway
Stockholm, Sweden
Copenhagen, Denmark
Madrid, Spain
Arbon, Switzerland
Bucharest, Rumania
Bombay, India
Delhi, India
Madras, India
Calcutta, India
Nairobi, Brit. E. Africa
Dairen, Manchuria
Shanghai, China
Tokyo, Japan
Osaka, Japan
Manila, P. I.
Perth, Australia
Adelaide, Australia
Melbourne, Australia
Sydney, Australia
Brisbane, Australia
Hobart, Australia

Nash Plants

Kenosha, Wis.
Racine, Wis.
Milwaukee.

Studebaker Plants

South Bend
Los Angeles
Walkerville, Can.

Auburn-Cord Plants

Connersville, Ind.
Indianapolis.

Hudson Motor Plants

Detroit
Tilbury, Ontario

Willys-Overland Plants

Toledo
Los Angeles

Graham-Paige Plants

Detroit
Walkerville, Ontario

Packard Motor Plants

Detroit
Windsor, Ontario
Australia.

Lubrication and fuel specifications for Diesel engines are discussed at an—

A. S. M. E. Meeting

A STUDY of Diesel fuels from several standpoints including fuel specifications, fuel sources, methods of production and evaluation was presented by W. H. Hubner and Gustav Egloff, Universal Oil Products Co., at the tenth national Oil & Gas Power Meeting of the A.S.M.E.* The survey on fuel specification which the authors completed May 15, 1937, is reproduced herewith in part as Table 1.

It appears that substantially all Diesel fuel for many years to come (at least in the United States) will be obtained from petroleum chiefly as straight-run and cracked distillates or mixtures of these. By straight-run fuels is meant the gas-oil fraction plus a percentage of the kerosene fraction. In some cases, part of the fuel-oil fraction may be included. Cracked fuels include redistilled pressure-distillate bottoms and distillates removed as side-cut material from the fractionating tower of the cracking plant.

While Diesel fuels may be derived from petroleum, shale oil, coal tar, or vegetable oils, it is agreed generally that fuels of a paraffinic nature give the best results for high-speed engines. Aromatic fuels are the least suitable. Between the two extremes lie fuels of the naphthenic and olefinic type.

The proportion in which straight run and cracked fuels are available from average crude by present refinery practice is shown in Table 2. From each barrel of crude petroleum processed in 1936, a total of 42.5 per cent of kerosene, gas oil, distillate fuels, and fuel oil was produced. This total would not have been suitable for the high-speed Diesel, but it appears that a percentage of kerosene and fuel-oil fractions could have been combined with the gas oil and distillate fuels to make available approximately 150 million barrels of suitable high-speed Diesel fuel. Some idea of the quality of the straight-run and cracked Diesel fuels which may be obtained from the various crude sources in the United States can be conceived from Table 3.

With regard to methods employed by refiners to produce required grades of Diesel fuel it is believed that cracked distillates will constitute the base fuel. Straight-run products will be added in

* Held Aug. 18-21, 1937, at State College, Penna.

Table 1—Manufacturers' Recommended Fuel Specifications and ASTM Diesel-Fuel-Oil Classification for High Speed Diesel Engines:

	High-speed (above 1000 r.p.m.) 25 Manufacturers Spread	Average	ASTM No. 1-D
1. Viscosity, S.U. at 100 deg. Fahr.:			
(a) Seconds, min....	34-40	36	35
(b) Seconds, max....	40-250	78	50
2. Gravity, deg. A.P.I.:			
(a) Minimum	16-30	26	..
(b) Maximum	29-45	35	..
3. Sulfur, % max.....	0-2.0	0.9	1.5
4. Hard Asphalt, % max.	0.05-1.0	0.51	..
5. Conradson Carbon, % max.	0-3.0	0.6	0.2
6. Ash, % max.....	0.01-0.05	0.03	0.02
7. Water and sediment, % max.	0-2.0	0.4	0.05
8. Flash Point, deg. Fahr. min.	135-150	148	Legal
9. Pour Point, deg. Fahr. max.	....	(a)	35(b)
10. Distillation Characteristics, deg. Fahr.:			
(a) 10% pt. max.....	460-475	465	..
(b) 90% pt. max.....	660-700	700	..
(c) E. P., max.....	650-700	680	..
11. Ignition Quality:*			
(a) Cetane No., C.C.R., min.	38-45	42	..
(b) Cetane No., C.C.R., min.	45	45	..
(c) Cetane No., delay, min.	35-45	37	45
(d) Diesel Index No., min.	35-40	38	45
(e) Viscosity-Gravity No., max.	....	..	0.86
(f) Boiling - Point-Gravity No., max..	....	..	188

(*) Ignition quality values cannot be considered entirely representative because of the differences in nomenclature used for expressing same.

(a) 10-15 deg. Fahr. below operating temperature.

(b) Lower pour points may be specified whenever required by local temperature conditions.

Table 2—Average Yield of the Various Products Produced from Crude Petroleum in the United States (5) for the Year 1936:

		Thousand Barrels	% of Crude
	Crude Petroleum:	1,098,516	100.0
1.	Engine Fuels:	470,907	42.9
	Straight-run	231,287	21.1
	Cracked	239,620	21.8
2.	Kerosene	56,082	5.1
3.	Gas Oil and Fuel Oil: ..	411,338	37.4
	Gas Oil and Distillates	125,650	11.4
	Fuel Oil	285,688	26.0
4.	Still Gas	54,441	5.0
5.	Lubricants	30,855	2.8
6.	Other Products and Loss	74,893	6.8

sufficient quantity to produce proper ignition-quality characteristics. The amount of each will depend upon the cetane ratings of both the straight-run and the cracked materials.

In the production of aircraft fuels, where high ignition quality and low cloud and pour points are required, indications are that other than normal refining methods may be necessary. In this connection it is reported that hydrogenation produces high ignition-quality low pour-point fuels from either cracked or straight-run oils. Indications are that fuels of 60-64 cetane number with pour points as low as —40 to —50 deg. Fahr. can be prepared with proper selection of charging stock. The hydrogenation process may be used also in the production of Diesel oils from coal. Several coal hydrogenation plants are now in operation, chiefly in Europe. Production of Diesel fuels by polymerization of olefins or alkylation of olefins and paraffins to produce paraffins can be accomplished when economic needs justify. Although the production of gasoline and lubricating oils by the polymerization of olefins either by high temperature and pressure or by catalytic means has been studied in detail, little work has been done in the preparation of Diesel fuels by this method. The low price of Diesel fuel compared to gasoline is the chief reason for this.

Additional information given in this paper includes tabular data on the following: Effect of cracking on pour point and ignition quality; effect of dewaxing on ignition quality and pour point; use of Paraflow as a pour-point depressor; effect of acid treating on ignition quality and pour point; and effect of solvent treating on ignition quality and pour point. The authors also discuss methods for evaluating Diesel fuels.

Table 3—Probable Cetane Ratings of Straight-Run and Cracked Diesel Fuels Produced from Various Crude Sources in the United States:

	1936 Production (5) Thousand Barrels	% of Total	Probable Average Cetane Ratings by Delay-Method (6) Str.-Run	Cracked
1. Appalachian: Pennsylvania	27,072	2.5	62	29
Kentucky (and others)	7,245	0.7	52	35
2. Michigan (also Lima & N. E. Ind.)	12,586	1.1	68	37
3. Illinois (also S. W. Ind.).....	5,243	0.5	..	..
4. Mid-Continent: East Texas.	168,046	15.3	55	40
West Texas (also S. E. New Mex.)..	88,649	8.1	45	30
Oklahoma (also Kansas, N. Texas	376,212	34.2	56	35
Arkansas (also N. Louisiana) .	37,364	3.4	..	..
5. Gulf Coast	139,160	12.7	58	41
6. Rocky Mountain	22,166	2.0	51	38
7. California	214,773	19.5	47	32
Total	1,098,516	100.0	..	..
Average Cetane Rating Based on Possible Production			54	35

Lubricating High-Speed Diesels

PROBLEMS of lubrication encountered in operating high-speed Diesel engines arise, to a considerable extent, from the deleterious influences of carbon and binder forming depositions. In a paper entitled "Lubricating Problems in Connection with High-Speed Diesel Engines" presented by C. G. A. Rosen, Caterpillar Tractor Co., at the tenth national meeting of the Oil & Gas Power Div. of the A.S.M.E.,* the author reported on a study of the causes and effects of carbon and binder forming depositions. Mr. Rosen pointed out that a recent survey of lubrication problems associated with Diesel engines revealed that manufacturers listed ring sticking as the most predominant and he discussed this subject first.

Lubricants which have a tendency toward forming hard, tenacious lacquers develop a lacquer film on the top surface of the piston ring. The film may not be of sufficient thickness to retard seriously the floating movement of the piston ring under normal operating conditions but when the engine is shut down lubricants with this characteristic show their most potent influence in ring seizure.

An aluminum piston drops very quickly to jacket water temperature directly after engine shut down. As soon as cooling begins after combustion ceases, vertical contraction of the ring groove tends to seize the lacquer film and clamp the ring in its groove. This clamping may not necessarily take place over the entire ring surface, but may be localized to limited regions only. However, even after the ring has been clamped, the radial contraction of the piston will result in the withdrawal

of the clamped ring or the clamped portion of the ring from its adjacent cylinder surface and produce a gap between the ring and the liner. Continuance of satisfactory operation depends upon how quickly the ring is unclamped upon subsequent starting of the engine.

If the carbon is soft and not tenacious, the floating action of the ring by the alternate thrust movement of the piston will keep breaking the carbon off the back of the groove, thus permitting some oil pumping and the desirable flushing action by circulation of the lubricant through the ring groove channels. If, however, the carbon is hard, dense and tenacious, it will only be a question of time before the ring will be constrained in its floating action and ultimately be clamped on the inner edge of the ring and result in ring sticking.

The accumulation of carbon with time, may be sufficient to pack the back of the groove so tightly as to block the floating action of the ring. There is, therefore, serious danger of ultimately rupturing the oil film and causing failure by cylinder and ring abrasion. The blocked ring makes a plug valve of the piston, and there can be no flexible flow of the ring face in conformity to the liner surface. A quick increase in load on a piston having a blocked piston ring would lead to almost certain failure.

In the further discussion of piston depositions, the influences of fuels and combustion systems were neglected. In all tests under scrutiny for this paper, the fuels burned were of a character which minimized deposition and the combustion system was free of aldehydes and soots from over-rich mixtures. The combustion chamber was clean in all cases and the fuel valves left no deposits on flame plates or piston tops.

Ring belt temperature influence carbon and binder depositions to the extent that a piston design can be offered which will prevent deleterious products from securing themselves to a piston and ring structure if load conditions can be controlled and if the type of lubricant and its characteristics are known.

Sometimes there are soft porous materials which may even fill the oil ring channel openings, yet do not materially hamper oil control due to the spongy absorptive quality of the material. The most serious deposits affecting oil control are those formations which build up like shingles, and are in reality particles overlapping one another in such a way as to block off the return channels, preventing the movement of surplus oil to the back of the oil ring groove.

In fast reciprocating Diesel pistons, it appears necessary to provide two oil rings to guarantee economical oil consumption for long time operation. It is true that an oil ring on the piston skirt below the piston pin is more effective at lower wall pressures than an oil ring would be at the enlarged clearances above the piston pin. It is, however, essential that a suitable vent be provided for the escape of gases and other materials to the inside of the piston immediately below the bottom compression ring. This position provides an ideal position for an oil ring for venting purposes. A far cleaner piston is obtained if the bottom oil ring is also placed above the piston pin, as this eliminates the sludge trap surrounding the piston pin region. Furthermore, the improved circulation and flushing action obtained with oil rings above the piston pin are quite advantageous for minimum depositions and lower wear of reciprocating parts.

Valve sticking of inlet valves in the high speed Diesel engine is largely a problem of dirt and dust contaminations and may be induced by air cleaner deficiencies. The sticking of exhaust valves is related to fuels and to lubricants, and to a combination of both effects. The carbonaceous materials in the exhaust gases find their way into the clearance of stem and bushing, and retard valve seating. The extent of these carbonaceous deposits from combustion gases varies with the fuels and the completion of combustion at the time of valve opening. The indirect effect from fuel deposition travels up the valve stem from below, whereas the influence from lubricants operates downward from above. In the use of straight mineral oils, it is customary to cut the supply of lubricant to the valve stem to the minimum, to restrict the formation of gummy deposits on the valve stem. When using compounded types of lubricants, however, it is desirable and essential to make use of the solvent power of the oil in assimilating the stem deposits by a copious supply of lubricant.

Filters

The subject of filters is one conducive to considerable difference of opinion. The function of a filter is primarily one of removing injurious materials from the lubricating oil system. What constitutes injurious materials appears subject to wide interpretation. A good filter, however, should be called upon to effectively eliminate abrasives, metal particles and water. Its effectiveness should further guarantee that the accumulations remain permanently separated and unable to reenter the flow of the system.

Some types of filters of the adsorbent principle not only remove the impurities accumulated in the lubricating oil system but remove the highly desired additives of compounded oils. Not only is there a decided growing tendency toward the use of these oils for Diesel operation, but we find on every hand the evidence of the use of additives in engine oils for such purposes as corrosion inhibitors, pour point depressors, and others. These ingredients, designed to yield specific operating virtues, are also removed by many of the clays and earths in use in adsorbent filters.

Liners and Piston Rings

Metallurgical considerations involve the material in liners and piston rings, as to those qualities which enable the lubricant to establish and support the necessary oil films. To obtain the proper cleavage for the lubricant to promote adherence of a film to the liner and ring faces, the graphitic carbon structure appears to be quite important. The percentage of graphitic carbon at the surface of piston rings requires its share in relation to the rubbing surface. Nodular or pin point graphite structures present difficulty in promoting oil spreading and film adherence. The presence of free graphite is highly detrimental to the proper surfacing of the ring faces. Chemical composition is of considerable influence in retarding corrosion tendencies from the combustion process.

Because of the tendency of certain combinations of ring and liner materials to exhibit what might be termed incipient scratching proclivities, there is need for lubricants of high load carrying ability. Operating conditions often set up difficulties in the matter of supporting suitable oil films. Quite recently considerable progress has been made in the development of additives which exhibit very superior load carrying ability, even under the most adverse conditions for film formation and support.

The manner in which raw machined surfaces are transformed into bearing surfaces capable of maintaining an oil film is of considerable importance in relation to the ultimate life of the liner and rings. It has been found that break-in methods, even over short periods of time, endow reciprocating surfaces with wear resistance which continues its influence after thousands of hours. The influence of additives for the promotion of short break-in periods has shown marked reduction in wear after many thousands of hours of operation. In other words, the influence of the chemical additives for even very short periods has its influence through-

(*Turn to page* 290, *please*)

False Brinelling

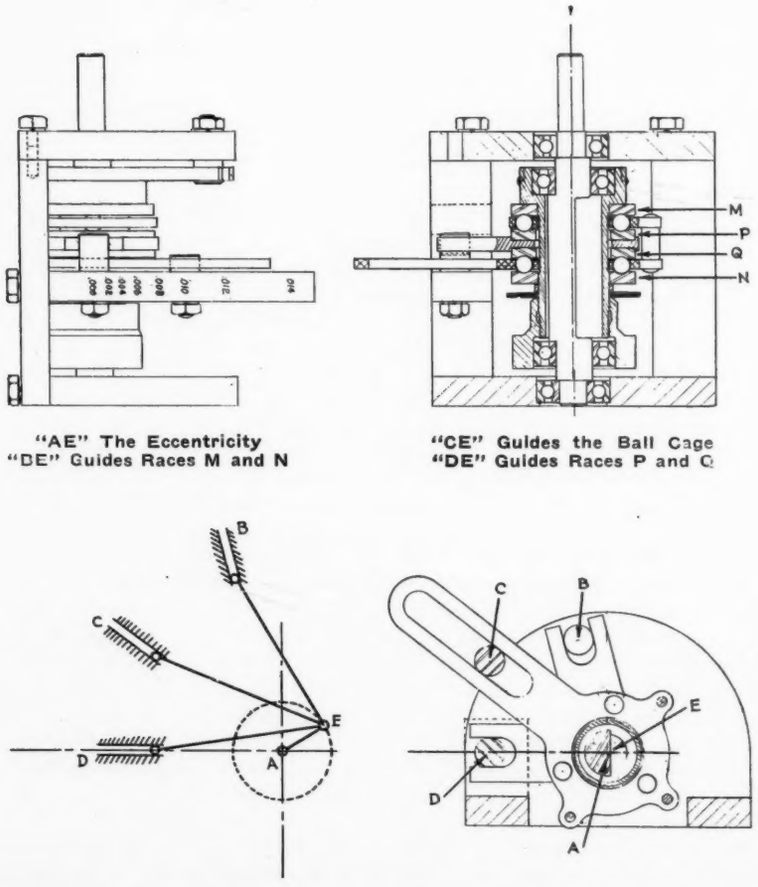
By J. O. Almen*

of ball and roller bearings. In this second instalment the author reaches some conclusions of interest. The first instalment appeared in the issue of August 14.

TO determine the cause of, and to find a practical remedy for, brinelling of ball and roller bearings, particularly in freight-car and motor-truck shipments of automobiles, the research laboratories section of the General Motors Corporation conducted a series of investigations. In preparation for the study of ball- and roller-bearing indentation, all available examples of this form of damage were examined. Automobiles shipped to the Pacific Coast were found to have suffered more damage than those going shorter distances, and, also, this damage was more severe in winter than in summer. The manner in which the automobiles were loaded in the freight cars had a great influence on the damage that was done, as cars carrying the weight on the wheels were damaged more than cars that were blocked up.

With this background, a laboratory-test machine was designed to permit wide variation in load, speed of operation, amplitude of vibration, and temperature, with the hope that it could be made to produce damage of the type occurring in service. The test specimens used are commercial ball thrust bearings, the races of which are caused to rotate relatively to one another through a small angle while loaded by a calibrated spring. Fig. 7 shows the construction and principle of operation. A framework supports a central shaft on two ball bearings, and a tubular structure is carried by the shaft on a second pair of ball bearings, the axes of which are slightly eccentric to the axis of rotation of the shaft. Test specimens, two commercial ball thrust bearings, are carried by the tubular structure and are loaded by a pair of calibrated disk springs. The load can be varied by adjusting the nut on the threaded end of the tubular structure which bears against the calibrated disk springs. The tubular structure carries a slotted arm that engages the guide pin *B*. As the shaft is rotated, the tubular-member assembly will be carried around by eccentrically mounted bearings the same as the big end of an engine connecting rod is carried around by the crankshaft. The two outer test specimens, races *M* and *N*, are held to the tubular member by friction of the spring load. The two inner races *P* and *Q* are held to a central plate by the same spring load. This

*Head Dynamics Dept., Research Laboratories Div. of General Motors Corp. at Detroit. From a paper presented to the A.S.M.E.



"AE" The Eccentricity
"DE" Guides Races M and N

"CE" Guides the Ball Cage
"DE" Guides Races P and Q

Fig. 7 Vibration wear-test machine that was developed by the Research Laboratories Section, General Motors Corp.

plate also carries a slotted arm that engages guide pin *D*. Special ball cages, accommodating three balls only for each of the two bearings, are riveted together so that both cages are guided by a common slotted arm, engaging guide pin *C*. The positions of guide pins *B* and *C* can be varied, guide pin *D* being fixed. If the axes of guide pins *B*, *C*, and *D* all coincide, the entire specimen assembly will move like the big end of a connecting rod without relative motion of the specimen races or ball cages. When guide pins *B* and *C* are adjusted, as shown in the end-elevation drawing and the diagram, the races guided by pins *B* and *D* will move relatively to one another through a small angle. The balls will, of course, move through half this angle. However, to prevent the balls from creeping, which would destroy the uniformity of the contact patterns, the ball cage is guided by pin *C* which lies on a line bisecting the angle *BAD*. The distance *AC* must be increased as the angle *BAD* is increased if the balls are to have their natural motion.

As built, eccentricity *AE* is 0.040 in., and pins *B* and *D* are 2 in. from the axis *A*. Angle *BAD* can be varied from 0 to 120 deg., and, by a simple calculation, the relative oscillation of the two sets of races can be varied from 0 to 2 deg., the movement of the balls on the races being, of course, one-half as great. The pitch diameter of the ball groove is 1.672 in., and movement of the balls on the races can be varied from 0 to 0.014 in. Spring load can be varied from 10 to 400 lb. per ball, corresponding to unit pressures, as calculated by the Hertz equation, of 97,500 to 332,800 lb. per sq. in. The machine is driven by an adjustable-speed direct-current motor.

In operation, bearing indentations closely resembling those found in practice could be produced by this machine. The region of damage was found to be surrounded by rust just as occurs in practice. Indentations resulted at low as well as at high loads, requiring, however, a greater number of oscillations at the former to produce equal damage. Damage was independent of the speed of the operating motor but was roughly proportional to the total number of oscillations. It was less at large than at intermediate amplitudes. Appearance of damaged areas on the test specimen were somewhat rougher than those of ball and roller bearings taken from actual installations, probably due to the fact that, in use, these areas are generally smoothed by rotation of the bearing after indentations are formed.

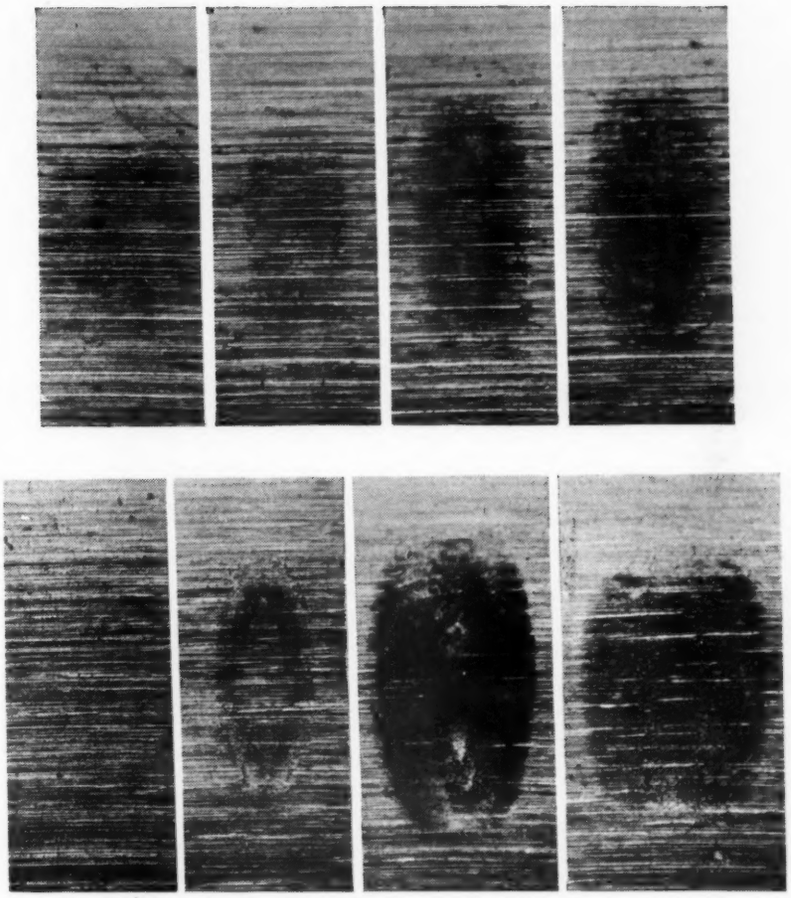


Fig. 8 Effect of varying loads and amplitudes of oscillation

(In the views shown in the upper row, the amplitude was kept constant at 0.006 in., and the load was 100, 200, 400, and 600 lb., reading from left to right. In the views shown in the lower row, the load was kept constant at 600 lb., and the amplitude of oscillation, reading from left to right, was 0.000, 0.004, 0.008, and 0.012 in., respectively. The constant-amplitude tests were run for 25,000 cycles, and the constant-load tests, for 100,000 cycles. The lubricant for each series of tests was sodium-soap grease to which 70 per cent of commercial winter extreme-pressure transmission lubricant had been added.)

Among the preliminary tests made with the machine were two series of runs designed to check service observations on the effects of load and amplitude of oscillation. Photographs of the contact areas for these tests at 48 magnifications are reproduced in Fig. 8, the upper row showing the effect on the three balls of total loads of 100, 200, 400, and 600 lb. each, when operated 25,000 cycles at oscillation amplitudes, of the balls to the races, of 0.006 in. and using as a lubricant sodium-soap grease to which 70 per cent of commercial winter extreme-pressure transmission lubricant had been added. Severity of the markings will be seen to increase with load. The lower group of four photographs, also at 48 magnifications, shows the effect of varying the amplitude of oscillation. These tests were run at a total load of 600 lb., 200 lb. per ball for 100,000 cycles, using as a lubricant sodium-soap grease to which 70 per cent of commercial winter extreme-pressure transmission lubricant had been added. Amplitudes, reading from left to right, are 0.000, 0.004, 0.008, and 0.012 in. Damage to the race is seen to be greater at the intermediate amplitudes than at an amplitude of 0.012 in. This is in agreement with the automobile universal-joint test and the service observations that were discussed earlier in this paper.

Relation of Viscosity to Race Damage

A series of tests was run on a large variety of oils and greases. Some of these lubricants are listed in Table 1

Table 1—Ability of Lubricants to Reduce Corrosion

Rating	Identification symbol	Temperature, F	Lubricant
1	*K*	70	S.A.E. No. 10W asphalt-base engine oil and aluminum soap
2		70	DuPont GD-153 extreme-pressure base; straight
3		70	Oleic acid; straight
4		70	Lard oil
5		70	S.A.E. No. 20W asphalt-base engine oil and 1½% of DuPont GD-162 extreme-pressure base
6		70	Castor oil
7	*G*	70	S.A.E. No. 20W asphalt-base engine oil
8		70	Raw linseed oil
9		70	No. 2½ cup grease and 1% of oleic acid
10		70	Experimental castor-oil grease and 5% of DuPont GD-153 base
11		70	SSG 06 steering-gear grease
12	*F*	70	Experimental lard-oil grease containing no mineral oil
13		70	Experimental castor-oil grease containing no mineral oil
14		70	Commercial wheel-bearing grease and 5% of pine oil
15	*E*	70	Sodium-soap grease and 70% of commercial winter extreme-pressure transmission lubricant
16		70	Sodium-soap grease, and 70% of commercial winter extreme-pressure transmission lubricant and oleic acid
17		70	Commercial extreme-pressure wheel-bearing grease
18		70	Experimental grease with 4.7% of zinc oxide and 5% of lead soap
19		70	Glycerine
20		70	Crisco, cooking fat
21	*D*	70	Commercial grease containing zinc oxide
22		70	Black lubricating oil of 90 viscosity at 210 deg. Fahr.
23	*C*	70	Commercial sodium-soap chassis lubricant
24		0	S.A.E. No. 20W asphalt-base engine oil
25		30	Experimental lard-oil grease containing no mineral oil
26		70	S.A.E. No. 20W mid-continent engine oil
27	*B*	70	Commercial slushing oil
28		70	Painters and varnish makers naphtha; immersed
29		70	Water; immersed
30		32	No. 2½ cup grease and 1% of oleic acid
31		30	Sodium-soap grease and 70% of commercial winter extreme-pressure transmission lubricant
32		29	Sulphur saponifiable extreme-pressure base
33		0	Experimental lard-oil grease containing no mineral oil
34		0	Sodium-soap grease and 70% of commercial winter extreme-pressure transmission lubricant
35		70	Sodium-soap grease and 30% of DuPont GD-162
36		0	Experimental castor-oil grease containing no mineral oil
37		70	Sodium-soap grease and 50% of sulphur base
38	*A*	70	Sodium-soap grease
39		70	Sodium-soap grease, 45% of sulphur base, and 10% of lead soap
40		70	Dry
[a]	*H*	70	S.A.E. No. 90 commercial winter extreme-pressure transmission lubricant

[a] This lubricant was not used in the comparison but was used on one of the specimens shown in Fig. 9.

(as shown above) in order of their ability to reduce the severity of race damage. In each case the machine was run at a total load of 600 lb. and an amplitude 0.006 in. for 100,000 cycles. The only property of these lubricants that appeared to determine their rating was the viscosity at atmospheric pressure and operating temperature. Because of their superior performance in heavily loaded gears, extreme-pressure lubricants were thought to be more effective in reducing bearing damage than normal lubricants, but all these lubricants also ranked in the order of their viscosities. This also was true for saponifiable oils. Several oils were tested at freezing temperatures and at 0 deg. Fahr., with the result that their rating fell in proportion to the viscosity change. This would seem to account for the increased damage occurring to automobile-wheel bearings in automobiles shipped in the winter.

Fig. 9 shows the test specimens for several of the lubricants listed in Table 1. These are arranged in opposite order to the table; that is, reading from left to right, the illustrations show the effect of decreasing viscosity. The worst of these lubricants, from the standpoint of test-specimen damage, is the type of grease commonly used for automobile-wheel bearings. The reason for this interesting fact is that the viscosity must be high enough to prevent leakage. A preloaded pinion bearing, filled at the factory with sodium-soap grease gave considerable trouble by brinelling during shipment to the West Coast. This trouble was greatly reduced when 70 per cent of commercial winter extreme-pressure transmission lubricant was added.

These tests and other observations indicated that, wherever possible, low-viscosity lubricants should be used in bearings subject to indentation. Following Fink's theory of oxidation wear, when heavy greases are used in such bearings, the grease apparently is pushed aside by the balls or rollers, and air is admitted to the area of contact with resulting rapid oxidation. Lighter lubricants are held to the balls and races and provide the contact area with a certain degree of protection against air and, hence, reduced oxidation. At low temperatures, oils and greases that are sufficiently fluid to provide protection for the bearings at room temperature may become too viscous to adhere to the balls or rollers. A lubricant for this purpose should, therefore, be one that adheres strongly to the balls or rollers and the races under all conditions of service and under the highest and lowest temperature that will be encountered. It should not drain off during long periods of storage but should be present in sufficient quantity so that the bearing can be run, as when the automobile is being loaded on the car, and still insure coverage for the contact region.

An attempt was made to meet these requirements by using an S.A.E. No. 10 engine oil with sufficient aluminum soap to give a viscosity approximately equal to S.A.E. No. 30 oil (lubricant *K*, Table

1), the rubbery consistency of this lubricant being relied upon to provide a cover and resist draining. A service test was arranged in which 25 preloaded pinion bearings were filled and assembled in axles. The axle assemblies were set aside in a position to drain at room temperature for two weeks, after which they were assembled in cars and shipped to the Pacific Coast in the late winter months. Inspection reported two bearings of the lot to be slightly noisy. Although not entirely satisfactory, this experiment seems to justify the theory on which it was based and, perhaps, indicate the characteristics that a better lubricant should have.

Protection Against Air by Plating or Submergences

As a further test of the oxidation-wear theory, a number of laboratory tests were run in which protection against air was attempted by other means that oils or greases. The photographs reproduced in Fig. 10 show the damaged areas after 100,000 cycles under a 600-lb. total load and 0.006-in. amplitude for various bearing-surface conditions. Reading from left to right in the upper row, these were dry, lubricated with water, and submerged in mercury. In the lower row, the conditions were, again reading from left to right, tin-plated balls and races, copperplated balls and races, balls and races coated with a tin amalgam, and balls and races coated with a copper amalgam. In all cases where the races were plated, the plating was removed before photographing.

The dry and water-lubricated specimens are shown for purposes of comparison. That tin and copper-plate do not protect the steel race is evident since the damage is similar to the unlubricated race. Increased damage for the specimen submerged in mercury may be due to the fact that air was trapped at the contact areas and, since this air was under increased pressure, it was possibly more active. The plated and submerged tests were intended to determine separately the effect of plated surfaces and the effect of mercury so as to isolate the effect of amalgam coating. With tin and copperplated races excluding air by adding mercury to amalgamate with the plating on the specimen and so penetrate into the smallest spaces was thought to be possible. The tin-plated specimen was wetted with mercury, the amalgam being formed by hand rubbing before the test was run. On the copperplated specimen, the amalgam was formed by running under load as an ordinary ball bearing, while submerged in mercury. The specimen was then assembled in the test machine and submerged in mercury for the test. The undamaged condition of the two amalgamated specimens may be due to superior effectiveness of the amalgams as lubricants, or as would seem more probable, it may be the direct result of exclusion of air. In view of the greater damage-resisting effectiveness of normal low-viscosity lubricants compared with normal high-viscosity lubricants, as shown in Table 1 and Fig. 9, the latter interpretation appeared to be justified.

However, a more direct test of Fink's theory seemed desirable. Rather than attempt the difficult technique of producing an oxygen-free atmosphere of nitrogen, the test was run in vacuum. The test machine and a 1/30-hp. alternating-current driving motor were placed in an ordinary 10-in. bell jar which was then pumped down to 0.00000002 atm. Before installation in the bell jar, the motor was disassembled and carefully dried of oil. The test machine was completely disassembled and all parts were successively washed in gasoline, benzol, dilute phosphoric acid, and, finally, in alcohol.

The test was run dry for 100,000 cycles at 600-lb. total load and 0.006-in. amplitude. A photograph of the test specimen at 38 magnifications is shown in Fig. 11 at the right. For direct comparison, the view at the left shows the same specimen run dry in air, other conditions being unchanged. This test shows that damage to the test specimen can occur in a highly rarefied atmosphere, although the damage is greatly reduced as compared with tests run in air. That the adsorbed-oxygen film on the test specimen was reduced in vacuum is not likely. Comparing the amalgam tests, Fig. 10, and the vacuum test, Fig. 11, the assumption must be made either that the amalgam offered better protection against air and the adsorbed-oxygen film on the test specimen than was given in vacuum or amalgam is indeed a superior lubricant. On either assumption, discarding the oxidation-

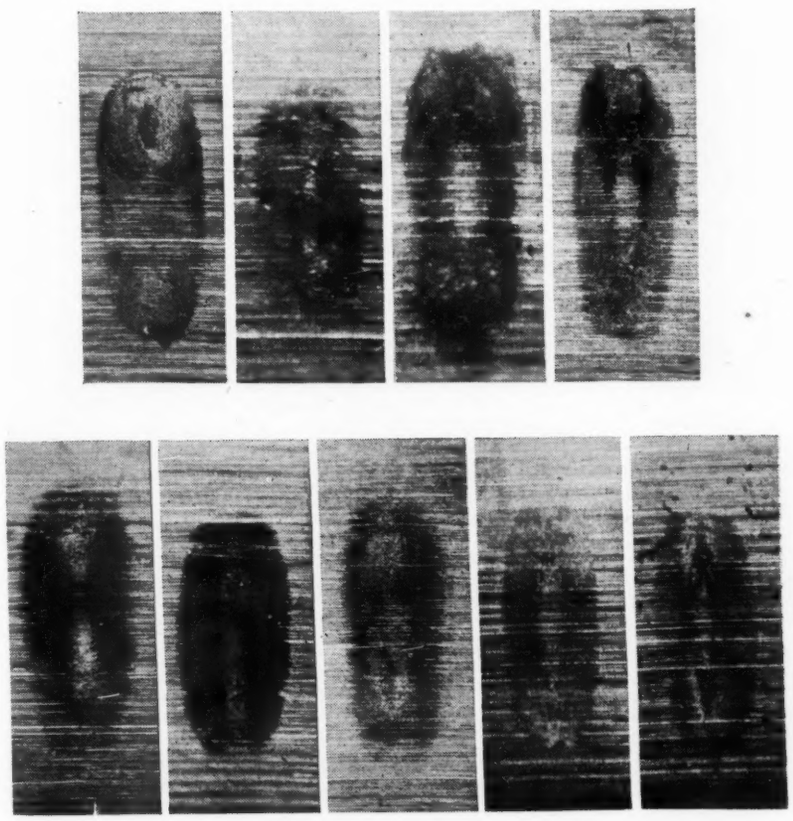


Fig. 9 Effect of varying the lubricant

(In these tests, which were run for 100,000 cycles in each case, the lubricants used for the bearings shown in the top row, reading from left to right, were sodium-soap grease, commercial slushing oil, commercial sodium-soap chassis-lubricating grease, and commercial grease containing zinc oxide. The lubricants for the bearings in the bottom row, from left to right in the order named, were sodium-soap grease to which 70 per cent of commercial winter extreme-pressure transmission lubricant had been added, experimental lard-oil grease containing no mineral oil, S.A.E. No. 20W asphalt-base engine oil, S.A.E. No. 90 commercial winter extreme-pressure transmission lubricant, and S.A.E. No. 10 asphalt-base engine oil to which aluminum soap had been added. The amplitude of oscillation and the load were held constant at 0.006 in. and 600 lb., respectively, throughout.)

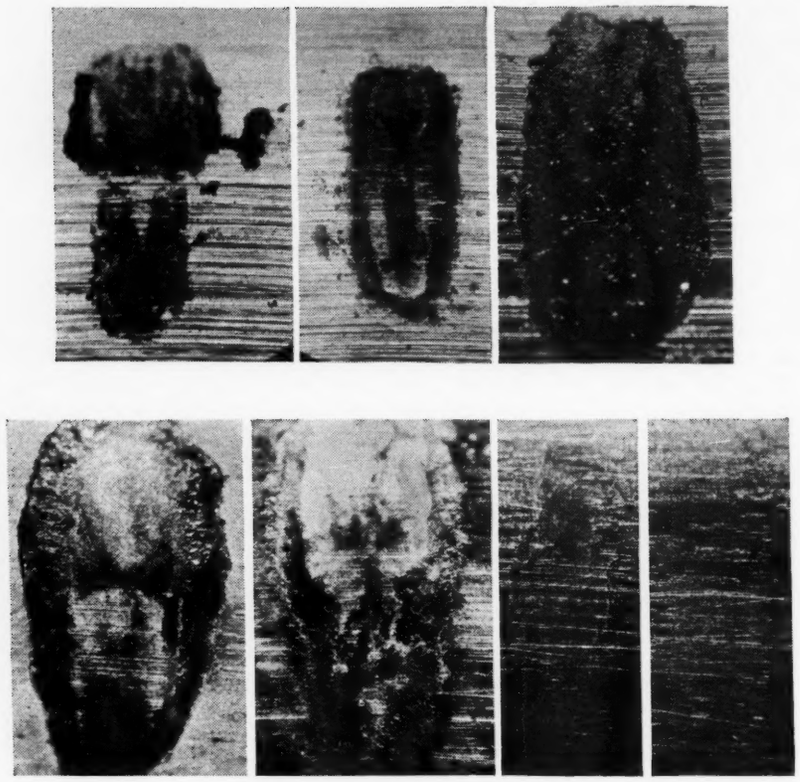


Fig. 10 Effect of various surface coverings

(The bearings in the upper row were of steel and were run dry, with water lubrication, and submerged in mercury; in the lower row, the balls and the races were covered with platings of tin and copper and amalgams of tin and copper, the order being from left to right in each row. These tests were run under the same conditions as Fig. 9: 100,000 cycles, 0.006 in. amplitude of oscillation, and a total load of 600 lb.)

wear theory is still not necessary. The total test load of 600 lb. corresponds to approximately 265,000 lb. per sq. in. for each ball, and the damage in vacuum may be purely mechanical removal of metallic particles under this severe load. In air, the damage may be the combined effect of oxidation wear and mechanical removal of particles. On this interpretation, normal lubricants provide a degree of lubrication as well as partial protection against air.

The nature of the damage produced in the test-machine specimen is clearly shown in Fig. 13. The damaged area shown in the top photograph was produced by operating for 500,000 cycles under 1200-lb. load and 0.007-in. amplitude. The other three following photographs show sections at 500 magnification through the specimen; section *A-A* is through an undamaged portion of the specimen which shows the original contour; sections *B-B* and *C-C* are taken through a portion of the damaged area, showing that particles of appreciable size were removed during the test.

Corrosion of Tightly Attached Machine Parts

Severe corrosion frequently is found on machine parts that are attached to one another in a manner designed to prevent relative movement, such as keyed taper shafts and hubs, press-fitted wheels and axles, and the like. Where such corrosion occurs, the attached members will be found to be subjected to fluctuating loads as from vibrations or from rotating loads. Two examples of this corrosion are shown in Fig. 12. One of these is a hardened automobile kingpin that corroded where it was attached to the axle. The second is an automobile front-wheel spindle showing a damaged region where the pressed-on inner race of a roller bearing had rested. In such cases, the corrosion is probably produced in the same manner in which indentations are produced in ball and roller bearings. The slight movement that seems to be

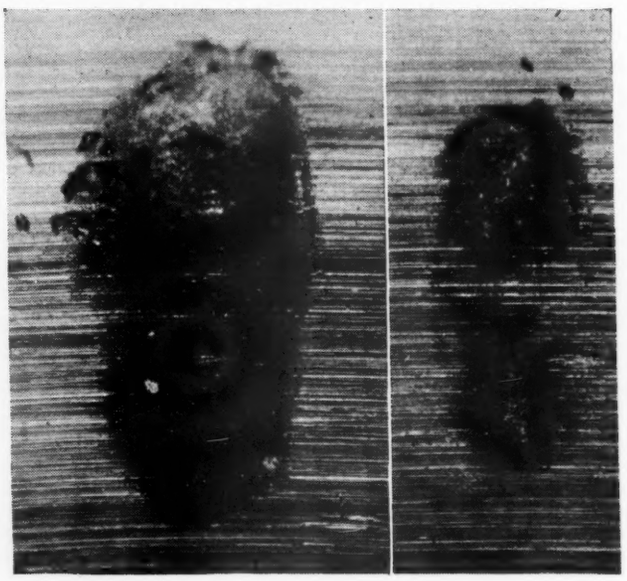


Fig. 11 Effect of an oxygen-free atmosphere

(The view at the left shows the appearance of a test specimen, 38 magnification, after being subjected to a total load of 600 lb. and an amplitude of oscillation of 0.006 in. for 100,000 cycles in air. The other view is of a similar specimen that was tested in a vacuum, pressure of 29.4×10^{-8} lb. per sq. in., all other conditions being the same. In both tests, the bearing had no lubrication.)

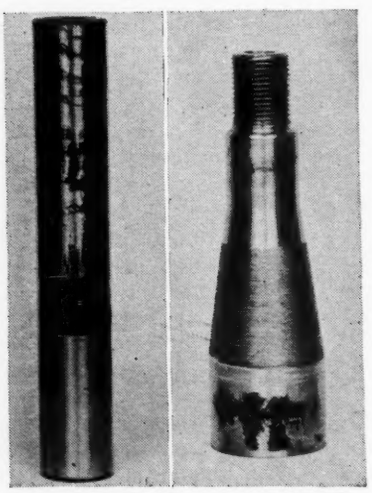


Fig. 12 Examples of corrosion in other automobile parts

(Left, a hardened automobile kingpin that corroded where it was attached to the axle; right, an automobile front-wheel spindle that shows damage where pressed-on inner race of roller bearing had rested.)

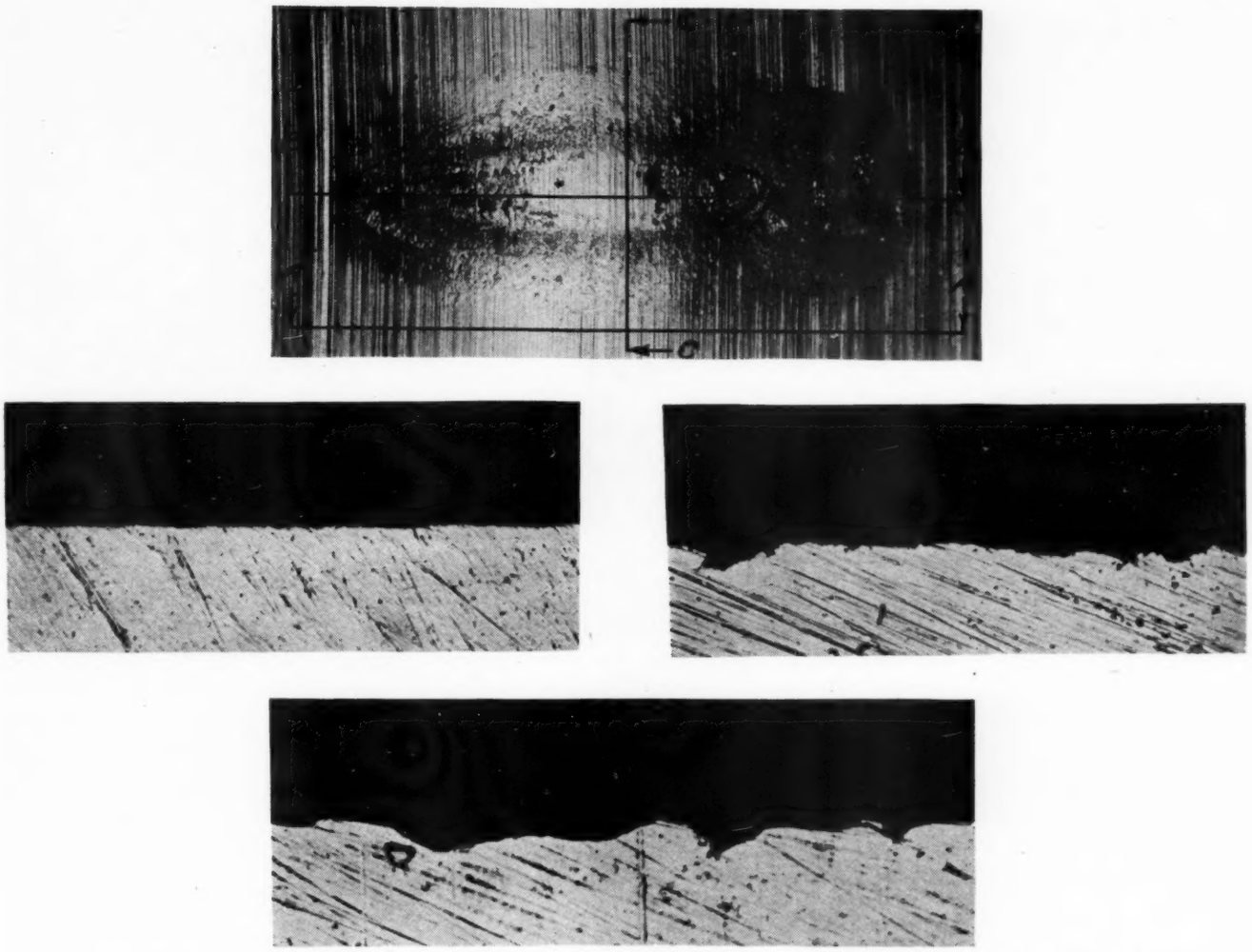


Fig. 13—Nature of damage produced by wear-test machine

(The top view, 35 magnifications, shows the damage produced by 500,000 cycles of operation with a 1200-lb. load and an oscillation amplitude of 0.007 in. when S.A.E. No. 20 asphalt-base engine oil was used as a lubricant. The view at the left center, 500 magnifications, is a section along the line *A-A* of the top view, which lies in the undamaged portion, and shows the original contour of the test specimen. The views at the right center and bottom, both 500 magnifications, are sections along the lines *B-B* and *C-C*, respectively, of the top view and show that particles of appreciable size were removed in the test.)

necessary for oxidation is present due to load variations and deformation under stress. These cases are mentioned to call attention to the fact that oxidation wear is not peculiar to ball and roller bearings but occurs on steel parts whenever high load and low slip are present.

This paper has discussed the effect of lubricants on oxidation wear of ball and roller bearings with particular reference to the damage that occurs during shipments of automobiles. The remedies that are applied in practice are various, depending upon cost. Where damage occurs on a large percentage of shipments, the cheapest solution is to support the automobiles on their axles instead of their wheels. Where this damage is of infrequent occurrence, the cheapest solution is the replacement of the damaged parts. However, a wide field still remains for development of lubricants that will better resist oxidation wear.

Conclusion

So-called brinelling of ball and roller bearings is not brinelling. The indentations that are observed result from a form of wear which is dependent on or aggravated by the presence of oxygen. This situation cannot become serious if air is excluded from the region of contact between the races and the balls or rollers. Oxidation wear can be greatly reduced but cannot be eliminated by the use of low-viscosity lubricants. Use of these lubricants for many installations of ball and roller bearings is impractical due to inadequate oil seals.

No general commercial solution is now in use. The remedy that is applied varies according to circumstances.

The author gratefully acknowledges the valuable assistance given by W. D. Gove and D. B. Elfes and the cooperation of the New Departure Manufacturing Co., the Timken Roller Bearing Co., and the Pratt and Whitney Aircraft Co.

Belt Lacing with High Tensile Strength

The Sudbury Laboratory, South Sudbury, Mass., is offering a new belt lacing only 0.005 in. in diameter It has been successfully applied to vee-belts and provides a joint with tensile strength of nearly 500 lb. The material, trade-named Tek-Lace, is a tough, flexible strand made of very strong fibers and coated for resistance against oil and water. It may be used for changing lengths of vee-belts, for repairs, or for installation where it is difficult to apply the belt in endless form.

Dynamic Research by Means of Oscillators

IN a paper read before the American Society for Testing Materials in New York, Rudolf K. Bernhard of the Baldwin-Southwark Corp., Philadelphia, described a method of dynamic research by means of oscillators. Each oscillator consists of two eccentric revolving disks (Fig. 1), an electric motor to drive the disks, and two measuring instruments, one to measure the frequency of the disks, the other to measure the power input (watts) of the motor. For more accurate results a special motor generator (Ward Leonard system), giving a closer regulation of the frequency, is desirable. To change the frequency, the resistance in the field circuits of the motor generator set are varied, for the gradual and exact variation of the voltage of the oscillator motor. To change the centrifugal forces, the eccentricity of the revolving masses is suitably adjusted. In speeding up the motor, the centrifugal force varies as the square of the cycles. For torsion tests the eccentricity of the two masses can be changed so that there is a phase difference of 180 deg. between them.

In making a test, the oscillator is rigidly fixed to the vibrating system (Fig. 2). Starting at a low speed, the frequency is raised gradually, and for each frequency the corresponding electrical input is plotted (Fig. 3). Instead of the input, the corresponding deflections, stresses, speeds, accelerations or phases may be measured. After having gone through the resonance points for a certain number of frequencies, the same curve can be plotted in the reverse direction by slowing down the oscillator, thus checking the first curve. If the two curves do not coincide it may be due to non-harmonic vibration.

All sorts of vehicles have been studied in some measure by the oscillator method. The damping qualities of a single spring or the entire spring-suspension system of automobiles, etc., have been investigated for vertical, horizontal and torsional vibrations. Any sympathetic vibration between parts carried by the spring and the

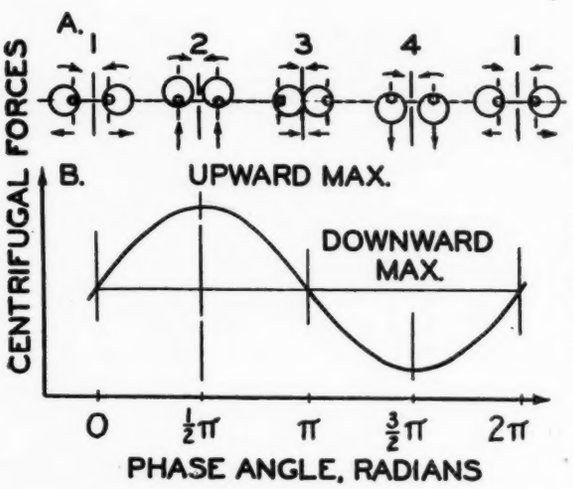


Fig. 1—(left) Exciting artificial Vibration

(A) Position of the two rotating massess during one revolution

(B) Corresponding centrifugal forces alternating in a sine form

Cases 1 and 3; horizontal forces neutralized

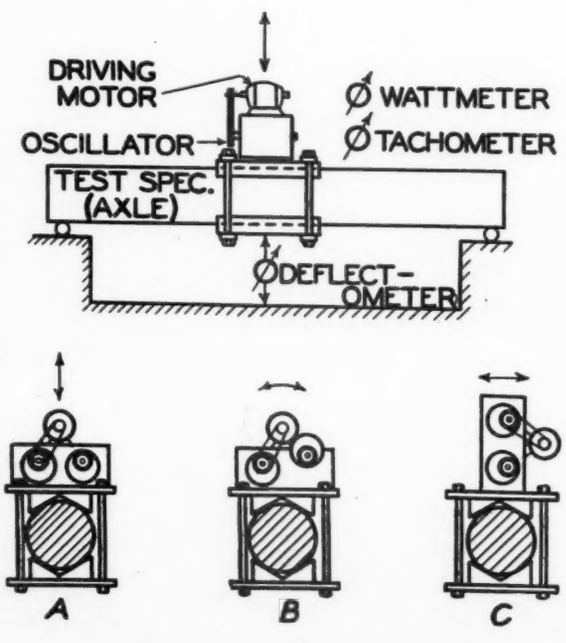


Fig. 2—(right) Schematic diagram of standard oscillator test

(A) Bending test

(B) and (C) Torsion test

In (B) the two masses have a difference in phase of 180 deg

supporting structure (such as a bridge) must be avoided.

In the aviation field the free vibration of a propeller blade or crankshaft, as well as the dynamic behavior of the whole structure has been investigated. One of the first failures of a Zeppelin was due to resonant vibration of the engine crankshafts.

The theory of the test was explained in an appendix. Nearly every system in the engineering field is capable of vibrating, and may be set in motion by alternating forces of a sine form. Such alternating forces of a sine form can be readily produced by two revolving masses, eccentrically supported, and moving in opposite directions (Fig. 1). The two horizontal forces are neutralized automatically. The two remaining vertical forces have a sine form with an amplitude dependent on the eccentricity and a frequency equal to speed of rotation of the two masses. The correlation between displacement A, speed V, acceleration a and time t is shown in Fig. 4, and can be explained in a simple way by one vector diagram (Fig 5), the vector diagram demonstrating the difference in phase of 180 deg. between A, and acceleration (a) or the difference in phase of 90 deg. between displacement and speed (ωA) Vibration of a simple spring-supported mass by such an artificial force from low to higher frequencies will cause the amplitude of any oscillating system to increase up to the so-called resonance point and to diminish after the resonance peak is passed. In Fig. 6(a) the abscissa may represent the frequency of the impressed forces (n) or the cycles per second of the whole vibrating system; the ordinates represent the power (watts) necessary for revolving the two masses. The three curves shown are for varying damping capacities; the centrifugal forces increase as the square of the rotational speed of the eccentric masses. In Fig. 6(b), three different phase curves of the corresponding system are shown. In most cases these fundamental curves determine with sufficient accuracy certain dynamic properties of any vibrating system. By changing the relative position of the two revolving masses of the oscillator, and by giving the two eccentric supports a difference in phase of 180 deg., the same tests can be carried out for torsional vibrations.

For normal tests, power-frequency curves are plotted (Fig. 3). The most important formulas for computing these curves are given below.

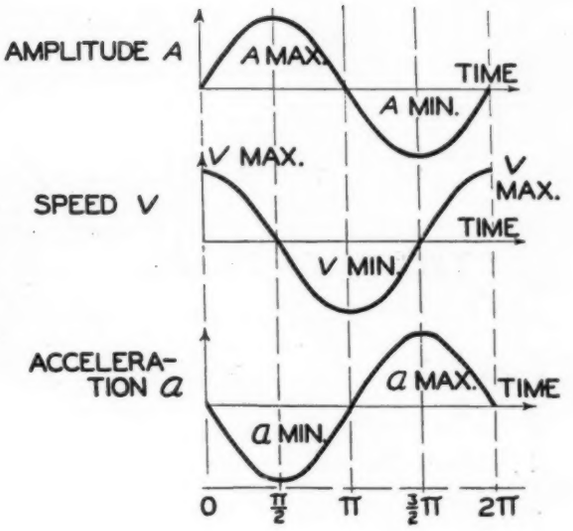


Fig. 4—Correlation between time-amplitude, time-speed and time-acceleration for one period

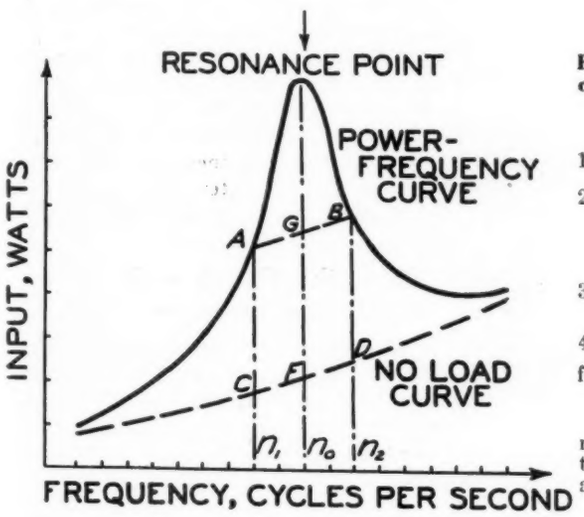


Fig. 3—Power-frequency curve. Manner of plotting test data.

Dynamic qualities:

1. Resonance period $= n_o$
2. Damping angle $=$

$$\tan \varphi = \frac{n_2 - n_1}{n_o}$$

3. Logarithmic decrement $= \delta = \pi \tan \varphi$
4. Dynamic amplifying factor $= F = \frac{\pi}{\delta} = \text{cotan}\, \varphi$

Line A-B through the middle of E-F is parallel to C-D and determines n_1 and n_2

Characteristic Frequency:

1. For small damping values (most structural systems) the peak of the power-frequency curve gives the resonance frequency n_o with sufficient accuracy (Fig. 3).

2. Phase measurements are independent of the amplitude and are more accurate. The frequency (multiplied by 2π) for which the phase between the exciting force of the oscillator and the amplitude of the forced vibration system is 90 deg., also gives the resonance n_o.

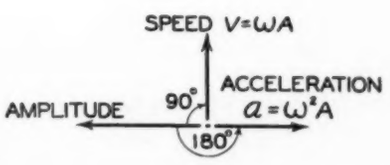
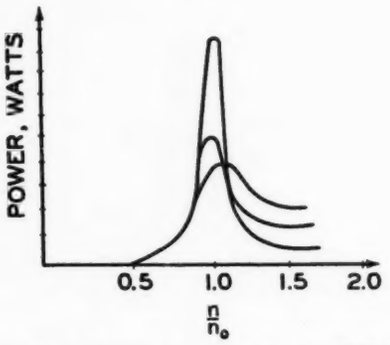
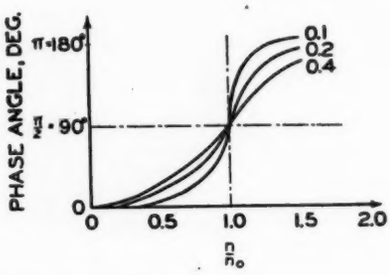


Fig. 5—Vector diagram



(a) Power-frequency curve for for-RMM ces, increasing with the square of theRMM cycles



(b) Phase frequency curve

Fig. 6—Correlation between power and phase angle and the ratio

$$\frac{n}{n_o}$$

$$\frac{\text{periods of exciting force}}{\text{natural frequency}}$$

for three different damping angles

Damping Values:

1. For small damping values, any line, *AB*, parallel to the no-load curve, *CD*, through the middle of the greatest amplitude *E* cuts the power frequency curve at the frequencies n_1 and n_2.

The damping angle is: $\tan \varphi = \frac{n_2 - n_1}{n_o}$

and the logarithmic decrement is: $\delta =$

$$\pi \cdot \tan \varphi = \pi \cdot \frac{n_2 - n_1}{n_o} \quad \ldots\ldots (1)$$

where δ is a dimensionless unit.

2. The damping values with phase measurements may also be calculated in another way. As soon as the frequency is 0.62 of the characteristic frequency, n_o, the damping angle is equal to the phase angle between the exciting force (oscillator) and the amplitude (vibrating system). The damping angle is tan $= \tan x$ for $n_x = 0.62\ n_o$

and the logarithmic decrement $\delta = \pi \tan x$ for

$$n_x = 0.62\ n_o \quad \ldots\ldots (2)$$

Amplifying factor

The time required for any vibrating system to change from zero to maximum amplitudes (stable equilibrium) is infinite. To get a definite time value, it may be assumed that equilibrium is reached as soon as the amplitude has attained 0.9 of its final value. The amplitude (A_{dyn}) is equal to the static amplitude (A_{stat}) multiplied by the amplifying factor *F*. The following equations may be used with sufficient accuracy:

$$A_{dyn} = F\, A_{stat} \quad \ldots\ldots (3)$$

$$F = \frac{\pi}{\delta} = \text{cotan}\ \varphi \quad \ldots\ldots (4)$$

With these four very simple formulas routine calculations of quite a number of vibrating systems can be carried out with little mathematical difficulty, and in most cases with sufficient accuracy.

A. S. M. E. Meeting

(*Continued from page* 281)

out the life of the reciprocating rubbing surfaces.

Quite recently material improvements have been accomplished in providing rapid and safe break-in by the use of chemical treatments on the cylinder and ring surfaces. The purpose of these chemicals is to endow the reciprocating faces with EP characteristics and encourage the rapid spreading of the lubricant during the break-in period. By transforming the cylinder surface to a blotter-like material, the lubricant is absorbed quickly and adhered tenaciously, thus permitting of a rapid form of mild abrasion which produces superior wear surfaces. The transformation of the chemically treated surface to a highly polished face endowed with film supporting characteristics is an accomplishment of the first magnitude. By this process piston rings which normally required about 100 hr. to obtain full ring face conditioning and 100 per cent bearing face can be run in to comparable surface contacts in 3 hr. time.

The lubrication of the connecting rod bearings in high speed Diesel engines involves the correct balance of temperature dissipation over the bearing surfaces with respect to design, materials, and lubricants. Under the pressure and temperature conditions prevailing in connecting rod bearings of fast running oil engines, there is an insistent demand for intimate contact of the bearing surface with the piston pin.

Of outstanding importance in the matter of maintenance of an oil film to support the bearing loads are conformity of the surface of the bearing to the pin and sufficient circulation of the lubricant to prevent those temperatures which cause destruction of the bearing material. The type of lubricant has an important influence on the rate of circulation and, therefore, the ability of the bearing material to support itself under the conditions prevailing.

Slate-Like Finish with Air-Drying Lacquer

Air-drying lacquer enamel, which finishes wood, fiber, wall board, cardboard, pressed paper, and other materials with a surface resembling slate, has been developed by Maas and Waldstein Co., Newark, N. J.

Known as "Slatite," the new finish takes chalkmarks like slate and the marks can readily be removed with an ordinary blackboard eraser, according to the manufacturer. The finish is washable and durable and, when it becomes worn, can be readily renewed by spraying on another coat of Slatite.

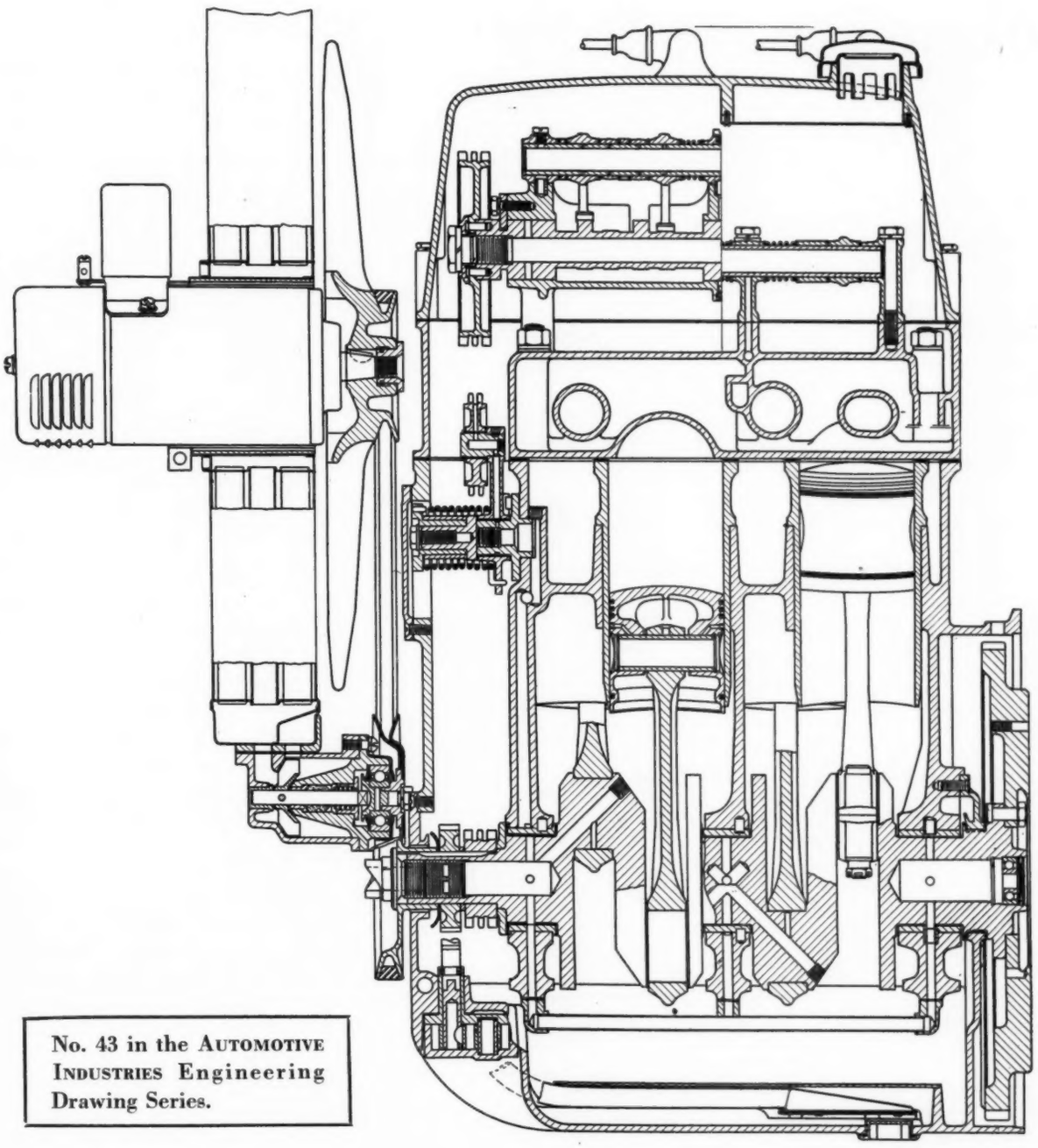
Color Code in Printed Form

The Division of Simplified Practice of the National Bureau of Standards has announced that printed copies of Simplified Practice Recommendation R166-37, color code for marking steel bars, are now available. The recommendation, proposed and developed by the National Committee on Iron and Steel of the National Association of Purchasing Agents, is limited to a color code for marking commonly used grades of steel as represented by SAE numbers.

LANCIA . . . .

passenger car engine designed and built by the Lancia Co., Turin, Italy. It is also produced by the French Lancia Co., near Paris, France.

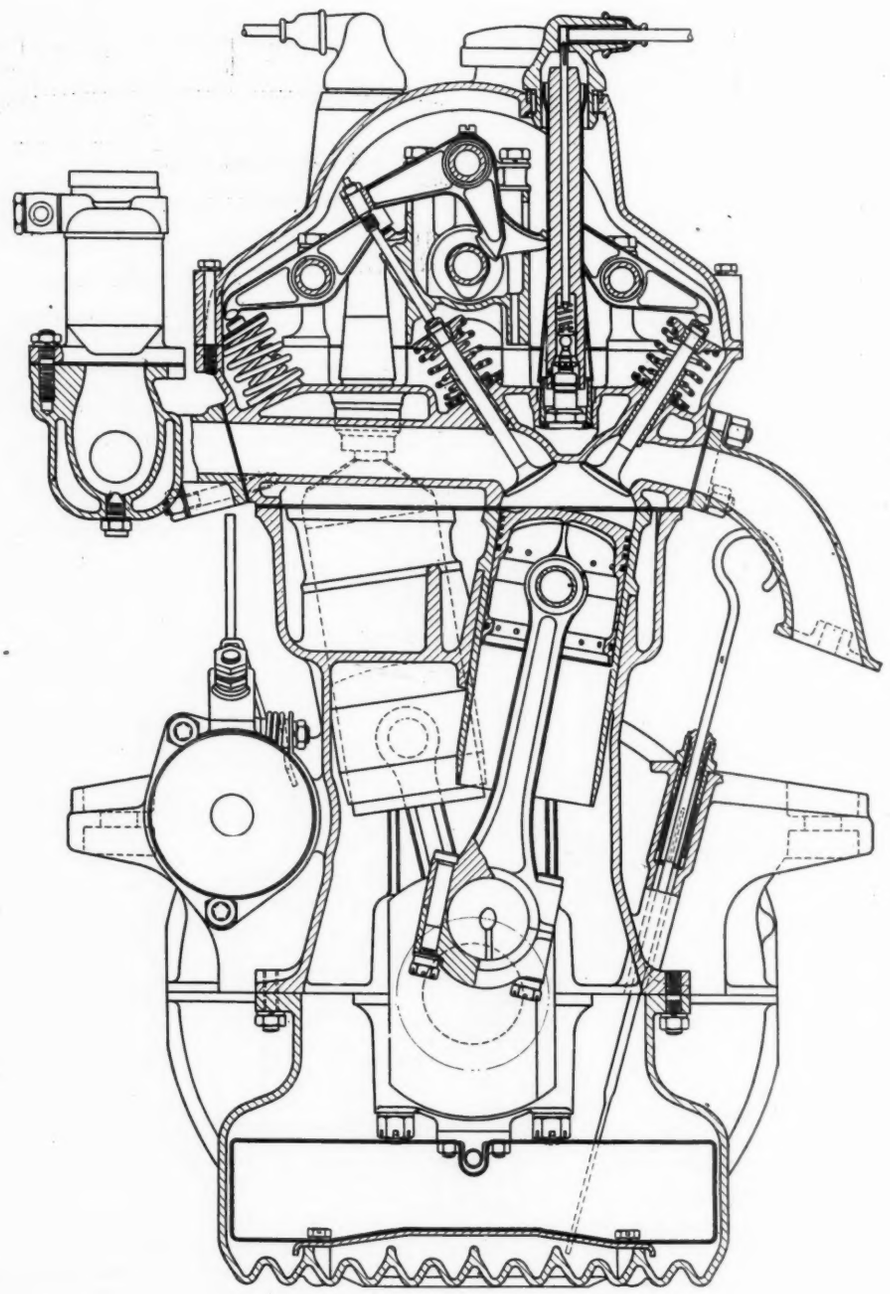
See description on the next page



No. 43 in the AUTOMOTIVE INDUSTRIES Engineering Drawing Series.

LANCIA . . . .

The Lancia model reproduced herewith in section is a vee-type, four-cylinder engine with a horsepower rating of 47 at 4000 r.p.m. Torque rating is 9 kgm. (65 lb.-ft.) at 2500 r.p.m. Bore and stroke dimensions are 72 mm. (2.83 in.) by 83 mm. (3.27 in.), giving a piston displacement of 82.5 cu. in. Compression ratio is 5.73 to 1. The cylinder head is made of cast iron and has a "hemispheric" combustion chamber. Pistons are made of aluminum and carry five rings.



A method for finding the radius of gyration of an automobile has been devised to determine the elements necessary for —

Greater Riding Comfort

By Arthur R. Parilla

A SIMPLE experimental method for determining the radius of gyration of the sprung mass of an automobile may be based on the theoretical analysis of Spring Suspensions by Professor James J. Guest.*

It has been shown that the maximum riding comfort may be obtained when $K^2/AB = 1$, where K is the radius of gyration of the spring mass, and A and B are distances from the center of gravity to front and rear wheels.

When this condition is attained, the body motion is one of independent rotation about a pair of conjugate points which lie over the wheel centers. A vertical displacement at the front wheel then produces pitching motion whose center of rotation is over the rear wheel, and produces no vertical motion of translation at the rear wheel.

This principle was applied by Sir Denistown Burney** in the design of his rear-engined stream-lined car to obtain the proper mass distribution for maximum riding comfort.

Experimental efforts have been made*** to determine the radius of gyration of conventional cars in which the car is swung as a horizontal pendulum in a cradle on springs to determine its period of vibration, from which K is computed.

In conventional cars, $K^2/AB \leqq 1$. This condition causes the conjugate centers of rotation of the spring system to lie at some point other than the wheel centers. A disturbance at the front wheel then causes the rear spring to compress or extend before the rear wheel passes over the disturbance. The rear seat ride is then aggravated by the two displacements at the rear wheel, one due to pitching and the other due to its own vertical displacement. The phase relationship between these two motions, for a given wheelbase, will depend on car speed. When the two motions are exactly in phase, the displacement at the rear wheel reaches its maximum, with minimum riding comfort.

By taking a chronograph record of the body motion at the rear wheel when the front wheel is dropped, the pitching motion of the car may be measured. The greater the inequality of $K^2/AB \leqq 1$, the greater the displacement at the rear wheel.

Thus it is possible not only to compare the inherent riding qualities of cars of different designs as affected by mass distribution, but the radius of gyration may be determined by this principle.

This may be done by adding a mass m to the sprung mass M of the car at some distance d from the center of gravity, varying the value of K', the radius of gyration of the total sprung mass $(M + m)$, until no displacement is measured on the chronograph at the rear wheel.

This, then, is the condition when $K'^2/A'B' = 1$, A', B' being distances from the new center of gravity $(M+m)$ to wheel centers, or

$$K'^2 = A'B'$$

The moment of inertia of the car plus the weights may now be determined from this value of K'. The moment of inertia of the added weight alone can be computed, and subtracted from the total, the result being the moment of inertia of the car alone, from which K may be determined.

The following equation for K in terms of measurable qualities can then be derived:

Let $M = W/g$ = mass of sprung weight of car whose c.g. is at 0.
K = radius of gyration of M about 0.
m = mass of added cylindrical weight of radius = r.
O' = position of c.g. of $(M + m)$.
d_1 = distance of m from O'.
d_2 = distance of O from O'.

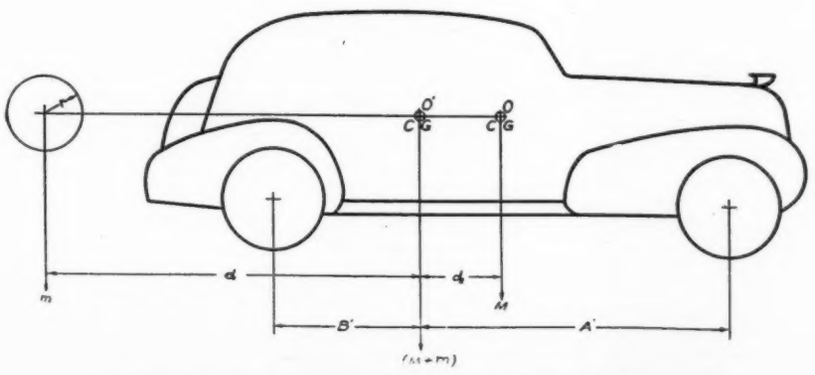


Diagram of the automobile as an oscillating body

** SAE Journal, Feb. 1932.
*** SAE Journal, Sept. 1935.
* If it is found large values of m are required this additional term may be included in the final formula.

K' = radius of gyration of $(M+m)$ about O'.
A', B' = distances from O' to front and rear wheel centers.
I_o = moment of inertia of M about O.
I_1 = moment of inertia of M about O'.
I_2 = moment of inertia of m about O'.
I' = moment of inertia of $(M+m)$ about O'.

From experimental data we have

$$K'^2/A'B' = 1;\ K'^2 = A'B' \quad \ldots\ldots (1)$$
$$I' = (M+m)\ K'^2 = (M+m)\ A'B'. \quad (2)$$
$$I' = I_1 + I_2 = (M+m)\ A'B' \quad \ldots\ldots (3)$$
$$I_1 = I_o + Md_2 = MK^2 + Md_2^2 \quad \ldots\ldots (4)$$
$$I_2 = 1/2\ m\ r^2 + md_1^2 \quad \ldots\ldots (5)$$

Since r is less than one, r^2 is small compared to d_1^2 and may be omitted with negligible error,* so that,

$$I_2 = m\ d_1^2 \quad \ldots\ldots (5a)$$

Substituting (4) and (5a) in (3)

$$M\ K^2 + M\ d_2^2 + m\ d_1^2 = (M+m)\ A'B' \quad (6)$$

solving for K^2;

$$K^2 = (A'B' - d_2^2) + \frac{m}{M}\ (A'B' - d_1^2) \quad (7)$$

Adding weights at large distances from the c.g. increases the value of K', while at the same time, the product of $A'B'$ decreases as the c.g. approaches one of the wheels. This will increase the value of the function $K'^2/A'B'$.

It may be found desirable to add weights both front and rear to increase K', in which case, an additional term is added to Equation (7).

When equal weights are added at equal distances from the c.g. of the car, the position of the c.g. of the combined mass remains constant, in which case $d_2 = 0$ and Equation (7) reduces to

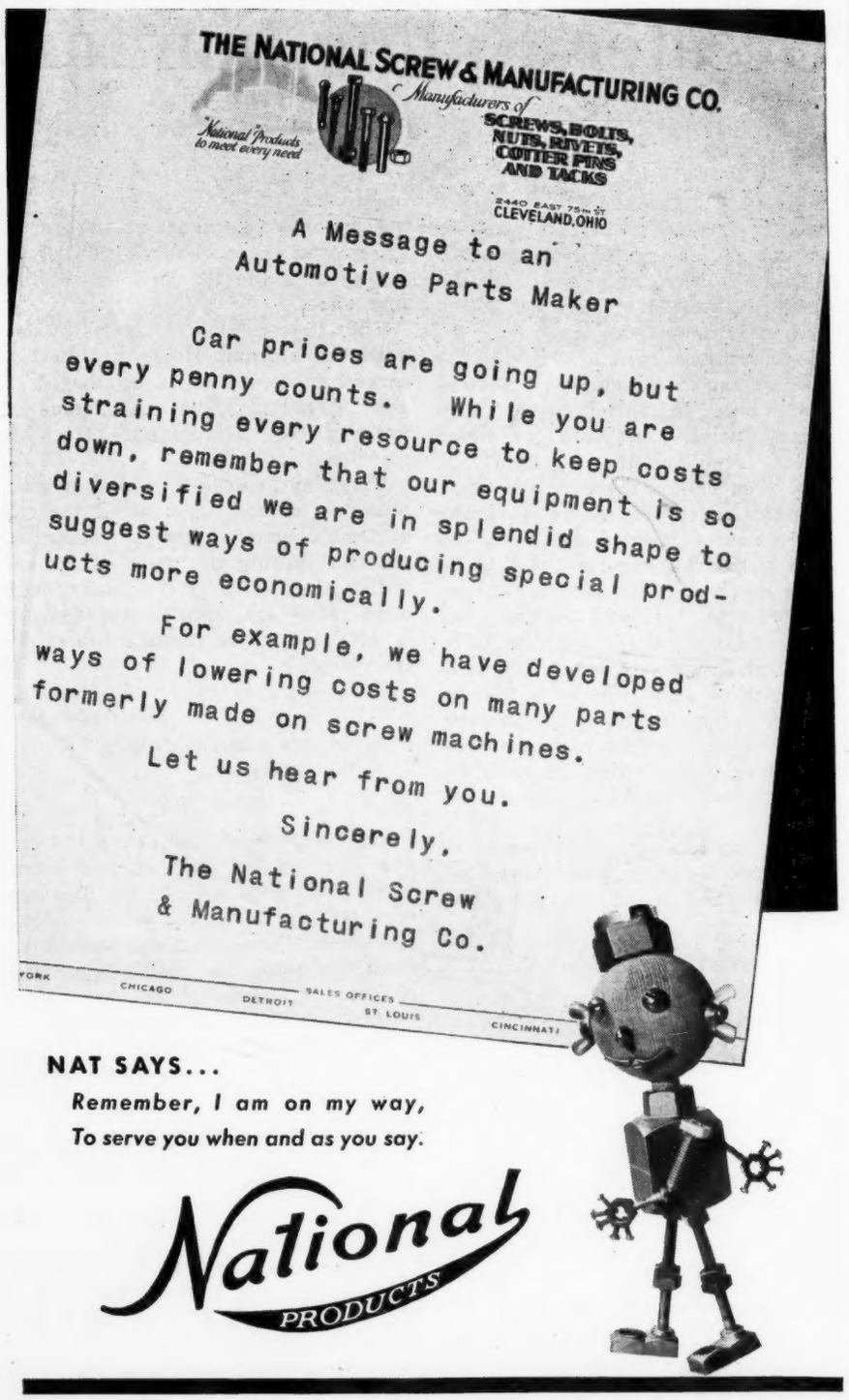
$$K^2 = A\ B + \frac{2m}{M}\ (A\ B - d_1^2)$$

Adding weights at or near the c.g. of the car decreases the value of K', while $A'B'$ has its maximum value when $A' = B'$, giving minimum values for $K'^2/A'B'$.

The degree of accuracy of the method may be estimated by finding how much K varies for values of m and d_1 which produce small oscillations on the chronograph.

The height of the free drop of the front wheel may be increased in order to detect the minimum motion at the rear wheel.

All damping action, such as shock absorbers, should be disconnected, and the spring-leaf friction reduced to a minimum, to permit the body to oscillate freely for the test.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For example, we have developed ways of lowering costs on many parts formerly made on screw machines.
Let us hear from you.
Sincerely,
The National Screw & Manufacturing Co.
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NAT SAYS...
Remember, I am on my way,
To serve you when and as you say.
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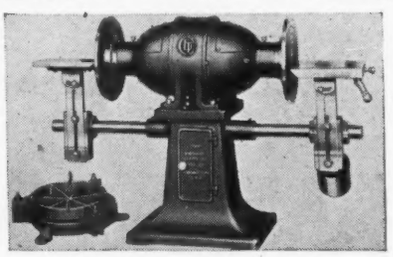
PRODUCTS

Cincinnati Electrical Disk Grinder

(Continued from page 273)

spindle is of nickel steel dynamically balanced and mounted on ball bearings.



Cincinnati electrical tool disk grinder

On the double disk grinder a table with hand lever feed is regularly supplied on the right-hand side of the machine with a plain table on the opposite side. This equipment may be changed to suit individual requirements.

Steel discs supplied as standard equipment may be had for either glueing on abrasive disks or properly drilled for mounting steel-back abrasive disks.